SIGMA XI QUARTERLY

VOL. 24 JUNE, 1936 NO. 2

THE SEMI-CENTENNIAL

COMPTON ON SIGMA XI AND THE UNIVERSITIES OF THE FUTURE

MASON ON SCIENCE AND THE RATIONAL ANIMAL

WHITNEY ON THE ACCOMPLISHMENTS AND THE FUTURE OF THE PHYSICAL SCIENCES

LILLIE ON THE ACCOMPLISHMENTS AND THE FUTURE OF THE BIOLOGICAL SCIENCES

(CIRCULATION THIS ISSUE OVER 12,500)

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The Semi-Centennial Memorial

SIGMA XI QUARTERLY

VOL. 24 JUNE, 1936 No. 2

PROGRAM OF
THE SEMI-CENTENNIAL

Friday Afternoon, June 19

a. Greetings from Cornell University, President Farrand.
b. Greetings from the A. A. A. S., President Conklin.
c. Response from the President of Sigma Xi, Dr. W. F. Durand.
d. A brief history of Sigma Xi, Edward Ellery.
e. Reminiscences by Mr. Frank Van Vleck, one of the founders.
f. Address: The Service of Sigma Xi in the Universities of the Future. Dr. Karl T. Compton, President of the Massachusetts Institute of Technology.

Friday Evening, June 19

a. The Semi-centennial Dinner.
b. Address: Science and the Rational Man, Dr. Max Mason, President, The Rockefeller Foundation.

Saturday Morning, June 20

a. Presentation of the Semi-Centennial Prizes.
b. Address: Accomplishments and the Future of the Physical Sciences. Dr. Willis R. Whitney, Vice-President of the General Electric Company, in charge of Research.
c. Address: Accomplishments and the Future of the Biological Sciences. Prof. Frank R. Lillie, University of Chicago.
d. The Semi-Centennial Memorial Tablet.
Presentation, Dr. W. F. Durand.
Acceptance, Dr. A. R. Mann, Provost of Cornell University.

THE FRIDAY AFTERNOON MEETING

The large lecture room of Myron Taylor Hall was crowded, every seat was taken and people were standing, when President Durand opened the celebration of the Semi-Centennial of the Society of the Sigma Xi at two o'clock, Friday, June 19. President Farrand of Cornell University welcomed the delegates and guests and visitors on behalf of Cornell.

PRESIDENT FARRAND

It is a very pleasant privilege that is mine to welcome this gathering of members of Sigma Xi to Cornell. We who live here are the appreciative beneficiaries of your visit.

It is not for me to dwell upon the ideals of the Society at this fiftieth anniversary we are celebrating but the spirit of research to the encouragement of which Sigma Xi is dedicated is a fundamental consideration for any university. If that spirit can be aroused even to the degree of habitual inquiry in the undergraduate the problem of education is largely solved.

When we deal with the problem of scientific research, with which this Society is particularly concerned, universities are puzzled by many practical questions. I assume that we would agree in general that our task is to find the exceptional mind and to provide the surroundings and the resources to enable that mind to function at its highest value. For the discovery of the exceptional mind I have never heard of any effective rule. It appears in unexpected and unforeseeable places. For the conditions which will enable that mind to work and work productively we not only can plan but must plan.

We have passed through a period where it appeared as if all universities thought they must strive for eminence or even preeminence in all lines of academic activity. This is not only obviously impossible but the effort is undesirable. An encouraging development is the way in which our universities are scrutinizing themselves, taking stock of their capacities as well as of their opportunities and responsibilities, consulting with other institutions in order to select fields of activity to which they may make contributions of value and leave to others emphasis on fields in which they themselves are less fitted to lead.

We welcome this gathering not simply as representative of a great deal of research but as a very practical opportunity for men of science to meet together, to match their thoughts and to give stimulus and enthusiasm to those who have the happy privilege to act as hosts.

President Conklin of the American Association for the Advancement of Science presented the congratulations and greetings of that great organization to which Sigma Xi is so intimately related.

PRESIDENT CONKLIN

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE SOCIETY OF THE SIGMA XI

The President of A. A. A. S. has been asked to extend the greetings and congratulations of the Association to the Society of Sigma Xi on the fiftieth anniversary of its birth, and point out the parallelism between these two organizations. Both have one function in common, the promotion of science, both seek to accomplish this by scientific meetings and publications and by the award of honors and grants-in-aid of research. But the Association seeks to correlate all branches of science and to secure the cooperation of all persons who are seriously interested in its promotion, while Sigma Xi is an honor society for those who have shown ability as investigators and who constitute a selected group of "Companions in Zealous Research."

The American Association is the largest, most democratic, and one of the oldest scientific bodies on this continent. It was organized in 1848, though its antecedents go back to the American Geological Society, which was founded at Yale in 1819. The Association now consists of fifteen sections, representing different branches of science, and it has more than 18,000 members residing in all parts of the United States, Canada, Mexico, and in nearly sixty foreign countries. Associated or affiliated with it are over 150 other scientific societies with a total membership of more than 500,000 persons. One of these affiliated societies is Sigma Xi.

The Association is thus one of the most important organizations in the world for the promotion of science. It is a forum before which scientists bring their discoveries and theories for discussion and criticism; it is a migratory educational institution, which by means of public lectures and exhibitions in different cities carries the spirit, aims and results of science to the general public; it is an important factor in helping to solve some of the most serious social problems of the present day.

These two organizations, as well as the many special scientific societies, have for their object "the increase and diffusion of knowledge among men." Each of our societies supplements and compliments the other. In 1921 the A. A. A. S. invited Sigma Xi to cooperate in our annual meetings by providing a Sigma Xi Lecture and these have been outstanding events of Convocation Week.

The A. A. A. S. congratulates the Society of Sigma Xi upon its notable record and wishes for it a future of ever greater service to science and mankind. We are especially appreciative of the program of this Semi-Centennial Celebration, which emphasizes the relation of scientific research to social progress.

This last is a particularly live topic at this time when many persons are charging that science is responsible for widespread unemployment and are suggesting that scientific research should be halted until social progress has had time to catch up—which would certainly never happen. The depression has brought out a flood of books and articles on this subject, non-scientists often calling for a moratorium on research, while scientists call for an extension of science and scientific methods to the solution of social problems. Eminent British scientists have shown that modern society does not suffer from too much science, but from

the "frustration of science" by the present social order. This is certainly a timely topic for a society devoted to the promotion of scientific research.

The marvelous advances in the production of food and clothing, of housing and transportation that have been made possible by science are known of all men. How has the social order met these advances? Superabundance of farm products is said to be one of our greatest social problems. And so on the one hand we find governments destroying or limiting the production of coffee, sugar, cotton, corn, hogs, calves, milk, potatoes, while on the other hand agricultural departments, colleges, and institutes strive to increase them. It is easy to point out this absurdity, but not easy to prescribe a remedy. However, it is certain that scientific progress in agriculture and industry will continue and the remedy must be found in a wider distribution of the products of scientific research.

In similar manner scientific progress in medicine and sanitation is far in advance of its social utilization but not in advance of its urgent need. Knowledge of heredity, eugenics, birth control and the means of improving our human stock is so far in advance of its practical application that the race is likely to suffer irreparable loss before this knowledge is put in practice.

And in similar fashion it might be shown that scientific progress in finding ways of protecting society against criminals and social parasites is far in advance of its general adoption; that rational and peaceful means of preventing wars are vastly less costly and more effective than armaments; that scientific control of population and the necessities of civilized life are far more humane and progressive than to leave these to nature and the law of the jungle. Here are some of the appalling contrasts between *Scientific Progress* and *Social Stagnation*:

Overproduction	*contra*	Underconsumption
Improved transportation	"	Unimproved distribution
Vast prosperity	"	Appalling poverty
Multiplied occupations	"	Unparalleled unemployment
Triumphant medicine	"	Widespread disease
Prolonged life	"	Useless and dependent old age
Scientific internationalism	"	Economic nationalism
Greater armaments	"	Less security
Larger social units	"	Less social unity
Elimination of unfit and survival of the fit	"	Protection of the unfit and elimination of the fit

The longer this list is made the more it appears as a conflict between progress and stagnation, knowledge and conduct, science and the social order.

It is easier to recognize symptoms than to diagnose causes, and both are easier than to prescribe remedies. The most fundamental cause of these contrasts is the conflict between altruistic science and acquisitive society, one working for abundance, the other for scarcity; one for goods, the other for prices. The profit motive is probably inevitable and not wholly undesirable, but in any stable society it cannot be the chief or only motive.

Different nations are now trying different remedies for this disparity between scientific knowledge and social practice. *Communism* in so far as it is based

upon the ideal that all men are equal in ability or character or social value, is scientifically false. In a democratic society all men are not and never will be equal in power, wealth or social value, but they do have equal rights to life, liberty and opportunity. Leadership of wealth may be as useful as any form of leadership—witness our great educational, charitable and scientific institutions established by private endowment. All "share the wealth" programs would be ineffective to change effectively the present status. Sharing all income above $5,000 would give only $200 to each of twenty million families, or approximately $50 to every man, woman and child in the United States.

Fascism is no satisfactory solution of the problem of insuring life, liberty and opportunity to every person. It destroys liberty of press, speech, thought and conscience; it censors science and religion, reduces the mass to the condition of robots and common fodder. It is based on war psychology, does not educate the people for peace and freedom, puts everything under a dictator who must maintain a reputation of supernatural grandeur. It may work well for a time, but always ends in disaster.

"Rugged Individualism" in the sense of "every man for himself and the devil take the hindmost" is no remedy for the present ills of society. We have had too much of this in the past to be content to go back to it now. It served well in a pioneer stage of society, but will not work in a crowded state.

Democratic Socialism seems to me the safest and sanest social order. It avoids the extremes of communism, fascism, and individualism, and yet contains elements of all these, and as such it conforms to that inexorable biological principle of the necessity of preserving balance between contrasting principles or opposing forces. Fanatical extremes of individual freedom or of social regimentation have no successful prototypes in biological or human history. Democratic socialism best preserves this balance in the social order.

It best preserves freedom of experimentation. The scientific method of learning is by experiment, trial and error, and finally trial and success. There is no other path of progress. Many mistakes are made, but with freedom to experiment they will be eliminated. This is the great advantage of free government. In this sense it is true as Lincoln said, that "A free government is better than a good government."

Democratic socialism is best for the education of the masses. The ultimate aim of all education, whether of children or nations, should be to fit for freedom and cooperation, and both children and nations must learn by experimentation.

The spirit of science and the method of science must spread to society and government. Scientists must take a more active part in solving social problems. Such progress will be slow but sure. Science and ethics are the chief hopes of social progress.

President Durand on behalf of Sigma Xi responded to the addresses of welcome.

PRESIDENT DURAND

RESPONSE TO THE ADDRESSES OF WELCOME

President Farrand of Cornell University and President Conklin of the American Association for the Advancement of Science:

On behalf of the Society of Sigma Xi, let me thank you most warmly for the gracious and kindly words with which you have signalized this occasion—the Fiftieth Anniversary of the birth of Sigma Xi. Our appreciation to you, President Farrand, because you represent Cornell University, the place of our birth, the source of our early inspirations and the Mecca of our members on this, our fiftieth birthday; and to you, President Conklin, because you represent the American Association for the Advancement of Science, the fostering mother of the organization of Science in our country, and because we are honored here today by the presence of that great organization in an official and collective sense, as a participant in the events which are intended to mark this occasion.

We thank you both for your kindly words and for the generous terms with which you have referred to our Society and to its work during this first half century of its life.

In particular I would wish that your kindly welcome and generous words should be understood as intended, not only for those who have the good fortune to be here present on this occasion, but also, more widely, for all our members, no matter where they may be found, in this broad land or beyond the seas. Doubtless they are here in spirit, perhaps through the wizardy of modern radio; others, at a later time, may read in printed word some account of these exercises, and I would hope that all such will feel that your words are addressed to them as well as to those within the immediate reach of your spoken words.

We are, as you have said, here to celebrate the fiftieth anniversary of the organization of the scientific honor Society of Sigma Xi. The present moment is not the time for any detailed reference to the history of this event or to the history of the Society during this past half century. This will come appropriately at a later time in our exercises as you will note from your programs.

If I may, however, be allowed a word, more personal in import, I would take the opportunity of expressing my own deep personal feeling and interest in this occasion. Coming to Cornell when the Society was only five years old, and accepted as a member, I remained for thirteen years in this atmosphere which had engendered the Society of Sigma Xi, and which had sent it on its mission throughout our broad land. The memories of the birth of the Society were still fresh in those years. I have known personally three of the founder members of the Society, and among them, Henry Shaler Williams of blessed memory. From one of the others, Prof. C. B. Wing, now *emeritus* professor of civil engineering at Stanford University, I bring sincere regrets that he cannot be present with us on this occasion, together with warm greetings to you all.

For these reasons, from my early acquaintance and association with these pioneers of our Society, by reason of my period of thirteen years spent most delightfully in the intellectual, social and physical environment which Cornell affords, the present occasion holds for me a peculiarly keen and special interest.

And so, through the years which have passed since those beginnings, our Society has come to the mid-point of the century. Of our history during that period, you will, as I have said, hear more in a moment. But in reviewing the past, we must not forget the future. The past has gone beyond recall. The future is still before us. We may draw lessons from our experience of the past; we have the future in which to apply these lessons. Let us then, while we think of the past, keep our faces toward the future with a firm resolve that, so far as in us may lie, the future of our Society shall show an ever-rising gradient of progress in the scope and effectiveness of its service to the cause of science and the scientific training of the young.

Again, let me express to you both our profound appreciation for your words of welcome and cheer to us on this occasion.

A résumé of the history of the Society of the Sigma Xi was given by Edward Ellery, general secretary of the Society.

EDWARD ELLERY

A BRIEF HISTORY OF THE SOCIETY OF THE SIGMA XI

Mr. President, Members of our great Society, and Guests:

A complete history of the first half century of the Society of the Sigma Xi will appear in the Half-Century Record and History of Sigma Xi which will be published in the early autumn of this Semi-Centennial year. What is here given is a curtailed statement of the important activities of the organization during the fifty years of its existence.

The Society of the Sigma Xi is a fifty-year-old youth movement on a high level and a large scale. It was started on the campus of Cornell University in 1886 by eight young students and one young instructor under the guidance, but not the control, of the justly well-known geologist, Prof. Henry Shaler Williams. Its purpose was and is to promote research in pure and applied science. The method followed in the pursuit of its object has always been the encouragement and recognition of excellence of college and university undergraduates and graduates in the pursuit of science courses. It associates into one body all students who exhibit special ability in science, regardless of the field of endeavor. The preamble of the first constitution sets forth this object and this method definitely.

> "Friendship in Science. While those whose heart and soul is in their work, are coping with the great problems of Nature, let them remember that the ties of friendship cannot be investigated, but only felt. Let them join heart and hand, forming a brotherhood in Science and Engineering; thus promoting and encouraging by those strong, personal attachments of friendship, the highest and the truest advances in the scientific field. To lend aid and encouragement to those newer brothers, who likewise laboring in the

same sphere are aspiring to honored positions. And in collegiate halls to award an honor, which to scientific recipients shall signify, 'Come up higher.'"

During the first quarter century of the Society's history, branches of Sigma Xi were established in twenty-eight institutions in which science and technology were notably strong, and 300 young men and women of marked accomplishment in science courses were annually elected to membership.

For twenty-five years the activities of the national organization were a summation of the activities of the twenty-eight individual units. But in 1913 and 1914 it began to appear that the Society as a whole was confronted with problems which affected not one chapter, or several chapters, but all chapters alike. A national policy became necessary. The first of these questions was connected with the inevitable expansion of the Society. What institutions should be given charters for chapters? A strict definition of conditions was made—president and trustees of an institution contemplating a chapter must be favorably disposed toward research; there must be apparatus and facilities available for research; there must be members of the faculty who have had adequate training for research; there must have been a continuous output of research for a number of years; there must be appropriations for research.

A second national problem arose about this time—what should constitute eligibility for election of young men and women into the Society? All students in the institutions where there were chapters had had opportunity to show excellence in science by their scholastic record, but only a very few had had a chance to exhibit an aptitude for scientific research by actual research work. The situation in the universities and colleges themselves made necessary a distinction among candidates for election into the Society, and eligibility requirements were strictly defined. Those students were eligible to membership who, as judged by actual scientific investigation, had exhibited an aptitude for research; and those who were eligible to associateship who had showed marked excellence in one or more departments of pure and applied science. In both cases it was always the ability of youth that was recognized and rewarded.

The second quarter century of the Society's history has seen further development of national policies as distinct from chapter activities, but the purpose of the organization as originally expressed by the nine young men who started it has never been lost sight of—the promotion of research in pure and applied science. On the contrary, the Society as a whole is realizing its object today more substantially than at any time in its history. The twenty-eight chapters of 1911 have grown to sixty-eight chapters in 1936. Chapters are no longer limited to the United States. Canadian institutions have been recognized, and inquiries about chapters in England and Europe have been received. Instead of 300 young men and women elected annually into the Society, there are now some 1,200. A constituency of 7,500 in 1911 has become nearly 35,000 in 1936. The membership of 1911 was largely limited in residence and work to the United States. Members and associates of Sigma Xi in 1936 are residing and engaging in scientific research in fifty-five different countries of the world.

National policies have expanded. The Society realizes the fact that there are youths in institutions where there are no chapters who have shown excellence in one or more scientific courses, and since 1934 has issued to such individuals

certificates in commendation of their work. Over two-thirds of the Society's constituency are either not connected with any educational institution, or if they have such connection, it is with institutions where there are no chapters. This large group are many of them engaged in actual research, and all of them are interested in the promotion of research. Sigma Xi clubs are authorized to organize wherever there is an interested group of members and associates, and since 1921 Sigma Xi members and associates outside educational institutions have been supporting a Sigma Xi Research Fund, which is distributed by the national organization in small grants-in-aid of research to young men and women who are carrying on scientific investigations in institutions of limited resources. The close of fifty years of constantly expanding activity is signallized by the award of two prizes of $1,000.00 each, not for research completed, but to young research workers in recognition and support of research in progress—one award to a worker in the biological sciences, and one to a worker in the physical sciences.

Thus throughout its fifty years of life, the Society of the Sigma Xi has recognized and rewarded ability in science on the part of young men and women. In that important aspect of its policies—the encouragement of youth—lies the ground for its prominent position among scientific organizations, the explanation of the influence it exerts on the advancement of science all over the world, and the confidence its supporters everywhere express in its brilliant future.

THE FOUNDERS

Three of the five living founders of the Society of the Sigma Xi were presented by President Durand and given places of prominence and honor at all the public gatherings. They were William Asher Day, of Sparta, New Jersey; William Addams Mosscrop, of Hempstead, New York; and Frank Van Vleck, of Washington, D. C. The other two living founders, John Knickerbacker, of Troy, New York, and Charles Benjamin Wing, of Palo Alto, California, were unavoidably prevented from attending the celebration.

President Durand read a letter from Mr. Wing and a letter from Mr. Williams, as follows:

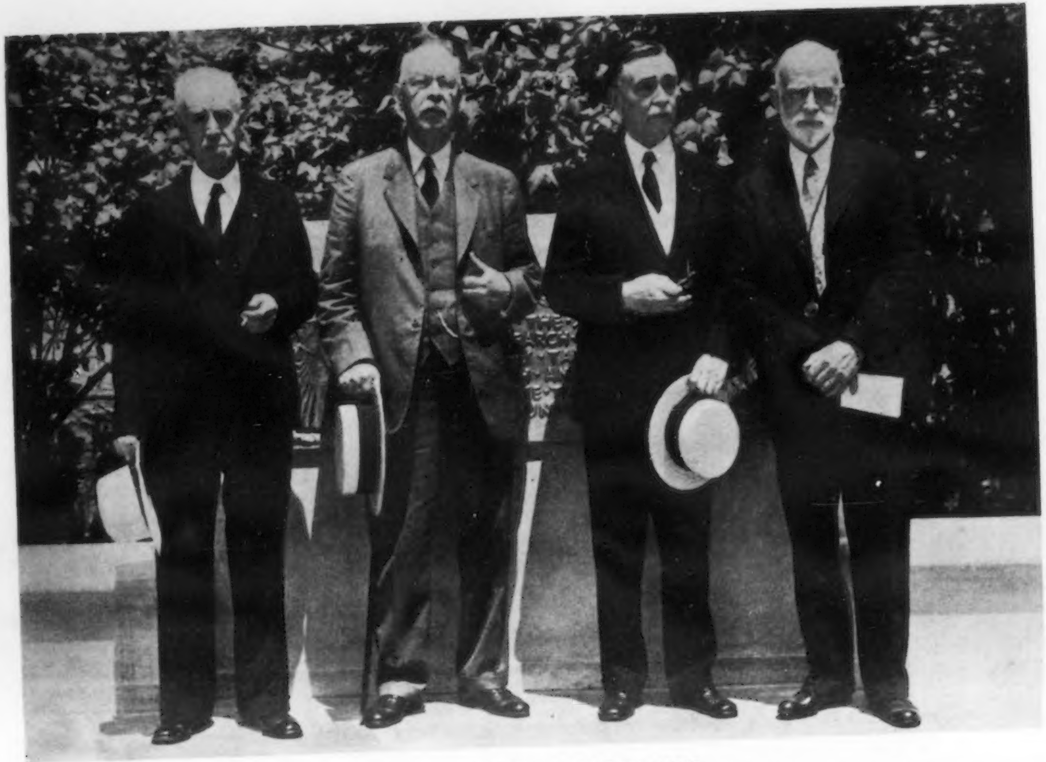
CHARLES B. WING
CONSULTING CIVIL ENGINEER
345 LINCOLN AVENUE
PALO ALTO, CALIFORNIA

June 8, 1936.

DR. W. F. DURAND, *National President,*
Society of Sigma Xi,
Stanford University, California.

Dear Doctor Durand:

I have delayed answering your letters personally urging me to join you all in Ithaca for the Semi-Centennial celebration of the founding of Sigma Xi, hoping that a change of circumstances might finally permit me to attend.



Founders and Present President

Left to right: W. A. Mosscrop, W. A. Day, Frank Van Vleck, W. F. Durand

As you know since reaching the retiring age at Stanford in 1928 I have been connected in an executive capacity in the acquisition of a park system for the State of California and since 1923 have been directing the activities of from 2,000 to 3,000 CCC enrollers in developing for public enjoyment and use the seventy areas acquired. As the month of June has been set as the date for me to transfer my responsibilities to my successor I feel that my duty to those with whom I have worked requires that I stay here until the reorganization is complete. With sincere regret I have been forced by a sense of duty to others to deny myself the personal gratification of joining in speeding Sigma Xi on a second half-century of achievement in the field of science both pure and applied.

Victor Hugo some three-fourths of a century ago stated that civilization has two problems to solve: the production of wealth and the distribution of wealth. I assume that in defining wealth he would include spiritual as well as physical values.

In the last half century we members of Sigma Xi have mostly given our attention to activities that have directly or indirectly helped in solving the first problem. Today need for the just solution of the second problem is most pressing.

For forty-one years my spare time outside of academic and professional engagements has been given to problems of park and civic development. Twenty-five years in executive work connected with state parks and twenty years as member of the city council of Palo Alto. Both of these activities have richly rewarded spiritually the efforts expended.

Palo Alto, a vacant field in 1893, has grown to a city of 15,000 inhabitants in 1930.

The California State Park System, begun in 1902 with the purchase of 2,500 acres of virgin Redwood forest, now includes 270,000 acres of forest, seashore, lake, stream, mountain, and desert. Wealth to be enjoyed equally by rich and poor, spiritually and physically according to individual capacity.

That Sigma Xi through research in the field of applied science can aid in the solution of the second problem is my firm belief.

Sincerely yours,

CHAS. B. WING.

ROGER H. WILLIAMS
40 WALL STREET
NEW YORK

June 4, 1936.

PROF. W. F. DURAND,
Stanford University,
Stanford, California.

Dear Doctor Durand:

Your kind letter of May 26 has just reached me as I am beginning work again after a repair job in the hospital.

I am greatly interested in the anniversary of Sigma Xi, whose formation I well remember through the conversations at home when my Father was working over its early aims and problems.

I deeply appreciate your invitation to attend the Semi-Centennial ceremonies as representative of my Father and it would be a great pleasure to attend it and to meet again such of his old friends as may be present.

However, it will be wiser not to try it. I find I am scheduled for three trips between now and then which will be a bit tiring, and I am not yet quite back to par.

In weighing the need and surveying the place for Sigma Xi alongside Phi Beta Kappa, I remember my Father once contrasted and characterized the scholarship honored by the latter as the conservator of the best in the past, whereas that honored by Sigma Xi is the guide across the untraveled fields of the future.

Whatever the validity of these contrasts, there is certainly in imagination a quality shared most notably by both groups.

First rank poets, musicians and workers in the field of *belles lettres* are quite generally classed as creative, but are any less so those scientific seers who frame fundamental hypotheses?

The growth and prestige of Sigma Xi gives its own answer, and when its Centenary comes around we may confidently believe that if the Society remains true to the aims of its founders, those it then honors will still be accorded high place in the Nation's esteem.

With all good wishes for the success of the celebration, and sincere regret not to be with you, I am

Faithfully yours,

ROGER H. WILLIAMS.

President Durand read the following poem dedicated to the ten founders, written by Charlotte Berger and printed in the *Schenectady Union Star*, June 6, 1935:

CUM LAUDE AETERNA

(FOR THE TEN FOUNDERS OF THE SOCIETY OF THE SIGMA XI)

Men of consecrated will,
Quick to sense a human ill;
Men of vision keen and broad,
Bridging spans 'twixt man and God;
Men of purpose, skilled endeavor,
Giving self to Science ever—
We salute thee. Sigma Xi
Lifts thy laurel wreath on high.

President Durand introduced Mr. Van Vleck to speak for the founders.

FRANK VAN VLECK

THE INCEPTION OF THE SOCIETY OF THE SIGMA XI

In an examination of the addresses delivered during this commencement season at the various universities of the country, it appears that the main theme is the outlook upon the future—but to me there has been assigned the task of looking backward, and to neglect being a prophet of the future, for all prophets are on uncertain ground, and to give the salient facts of the past which led to the inception of the idea for the organization of the Society of the Sigma Xi.

The need of a society in colleges to recognize the scientific spirit and acknowledge research, was not altogether new, fifty years ago. Science in fact was energetically pushing up its head amid the devotees of classical culture, and it was occasionally accentuated by profound scholars, that the study of the classics—Greek and Latin, while of a certain cultural value, were not of necessity a mental or even educational training such as best fitted students for a scientific career, nor for deep research, nor even as a preparation for the activities of life.

As a junior student at the Stevens Institute of Technology, there came to my attention, a Commencement Day address before the Phi Beta Kappa Society at Harvard, June 28, 1883, by Charles Francis Adams, Jr., of Boston for which he selected the unique title "A College Fetich." This address stirred the classicists from one end of the country to the other, and even had its rebound into England and Germany.

First let us indicate who this Charles Francis Adams, Jr., was. At the time he was president of the Union Pacific Railway—hence spoke as one with authority. He was one of the celebrated family of Adams that had supplied two presidents of the United States (and in passing can now say that a recent Adams of the same name was our Secretary of Navy during the Hoover Administration). This Phi Beta Kappa address seriously challenged all claims for the study of the dead languages to have educational value. In fact, he said that this study of the Greek and Latin had been like a millstone about the necks of all the family and all others who aspired to careers in science or even in politics and diplomacy, that such study as feats of memorizing was the correct thing for those who expected to become professors of these languages; but that as working tools of life, a knowledge of French, German and Spanish was far preferable, and that for close and exact mental drill, the higher mathematics, chemistry, biology and electricity were then most essential.

Let us quote some of Charles Francis Adams' surprising phrases which still cause students of these fifty years later to think. He states, talking to his classmates of 1856, "And so looking backward from the standpoint of thirty years later and thinking of the game of life which has now been lost or won, I silently listen to that talk about 'the severe intellectual training' in which a parrot-like memorizing did its best to degrade boys to the level of learned dogs, and further "we want no more classical veneer whether on furniture or education, we do not admire veneer."

These were indeed harsh words, from one of a family steeped in the classics, and thus delivered before the Phi Beta Kappa Society, they caused one to think,

whether that Society's insistence on the classics was well taken, and if so insisted upon whether another society should not be established to recognize high standing of those following scientific studies.

Do not conclude from this that your speaker himself had an aversion to such classical studies—for my own father was a deep classicist and in the ministry delved deeply not only into his Greek and Latin, but into Hebrew and the Germanic languages, and the intention was that his son should follow in his profession.

The son, captivated by the researches of Alexander Graham Bell into telephonic electricity and Edison into the phonographic recording and the incandescent lamp, early decided for himself that the classics had nothing comparable to offer in the pursuit of these new rapidly growing sciences. It should be recalled that these sciences and the researches connected therewith had but barely started fifty years ago and the crude developments of that time if recounted to you would seem now almost improbable to the young trained scientists of today who work with instruments whose names and measurements were then not even evolved.

Finding myself on the instructing staff at Cornell University in 1885 in the Sibley College of Mechanical Engineering, soon friendship of all kinds were made among such instructors, and among students, and shortly thereafter four of such were gathered together in one group at a boarding house—still highly remembered for its homelike atmosphere fostered by a most kindly and lovable landlady. Of these four friends—two were deep classicists and two were engineers. Our classical friends Burr and Thurber (Burr later became a professor in Cornell, and Thurber an authority with Ginn & Company, Publishers). Both of these attempted to console the two engineers (Van Vleck and Wing—both later becoming professors) that the rewards of an honorary election to the great Society of the Phi Beta Kappa was not for those so soaked in science as we were, and who could not read in the original, Caesar's Commentaries nor enjoy the orations of Thucidides or some other Grecian. Thus we did not hold any particular sorrow that we had missed such an honorary election, and both Wing and myself made the pronouncement, that a new honor society for scientific men only would in time duly arise—but little did we two dream that we would be the agents for such a new and untried organization, either at Cornell or any other institution.

This start was even sooner than anticipated—and was brought forward by the suggestion of Mr. W. A. Day, Cornell '86, to myself as we toiled up the Ithaca hill from town in 1886, essentially as recounted in a letter appearing in the quarter century volume of Sigma Xi.

The organizing machinery was soon put in motion, and in the fall of 1886, shortly after the opening of the University, these plans were put into effect.

Here it should be said—that our plans were often talked over with our roommates Burr and Thurber, and they gave much excellent advice, although we jokingly informed them that as sincere friends, we could not award them any honor of an election, as being mere classicists, they could not understand the

deep "cultural advantage" to be obtained from a close and exact study of the sciences.

Again these classical friends did come to our aid—for when the subject came up for a new name for the Society—Mr. Burr at once said, "Don't make the mistake of calling the new society with an English name, but give it at once a Greek classification name—much as you dislike reference to the classics, and if for nothing else the use of Greek initials marks it at once as a thorough-going collegiate organization." This appeared sound advice, and it was determined that I should canvass among all the even then large number of Greek fraternities and select some set of Greek initials that had not already been preempted by some other fraternity. There were not many such initials available, but we did find that Sigma Xi was not in use. Then the problem came up of a definite Greek motto to fit these initials. Wing and myself having no knowledge of Greek much beyond its alphabet were helpless, but Burr suggested "give me a little time and I can find it for you." Later he evolved the two-word motto, and referred it to the then professor of Greek, who polished it up for accent or something. Still later when Prof. Henry Shaler Williams, head of the department of geology, was brought in, we had him look over the motto and he approved it without a change and so it has remained ever since.

An idea of the motto was also that of confirming the thought of a friendship among scientific workers, as it had been observed that in the records of European scientists as Faraday, Helmholz and others that there had often been an interchange of scientific views between scientists even when differing in nation and often in language, indicating that they were working as friends and often comparing notes as to their difficulties, whereas in America, outside of the special professional societies there at that time appeared to be little in the way of close intimacy among scientists themselves. Research workers themselves often need this feature of the personal contact, with someone who can think along the same lines as they are working upon.

As one of this diminishing group of the nine founders of this Society, permit me to extend our appreciation of the efforts of the officers of the Society and of the Cornell Chapter to have us all here for this Semi-Centennial Celebration, and to witness the dedication of the handsome monument on this campus, as a fitting mark of this event.

And this little group of founders desire to thus express their deepest sense of appreciation for the excellent administration that has distinguished this Society in every phase of its existence for these fifty years, and to wish for the continuance of the great and good work of the Society for the years to come.

The address of the Friday afternoon program was given by Pres. Karl T. Compton of the Massachusetts Institute of Technology.

PRESIDENT COMPTON

THE SERVICE OF SIGMA XI IN THE UNIVERSITIES OF THE FUTURE

The subject which has been assigned to me, "The Service of Sigma Xi in the Universities of the Future," could be approached from a variety of points of view. I might attempt to forecast the trends in science of the next generation, or I might try to formulate a specific program of objectives for the Sigma Xi itself, or again, I might try to arouse you to a pitch of enthusiasm by an eloquent burst of oratory after the manner in which the political leaders rally their ranks at a convention. In part through preference, but principally because of my personal limitations in wisdom and eloquence, I have chosen to approach this subject rather from the viewpoint of the opportunities and the needs for science in our national program, with the thought that the combined wisdom of my many colleagues in this field, the altruistic interest of many benefactors in science, and the progressive leadership which exists in American industry and occasionally in American political life will combine to develop an adequate program in science to meet these opportunities and needs.

In any such program the Society of Sigma Xi will play an important rôle in many ways. Most important, I believe, is its stimulation and encouragement to the new generations of scientific workers who, year by year, enter the fields of research and become the workers and leaders in the sciences of the following decades. A second valuable influence lies in the prestige and dignity which this honorable Society gives to the cause of science in the minds of the general public. This prestige is of far greater importance than in providing a mere ora of satisfaction in which the scientists themselves may take pleasure. The really important influence is the strengthening of the confidence of the mass of our people in the value of accurate knowledge and its applications as a guide to conduct and policy.

In Plato's Republic, that philosopher pointed out as one of the great dangers of a democracy the tendency of its leaders to fall under the spell of enchantment. By this he meant the lure of new and untried panaceas for all types of social and economic ills. The cure for enchantment, like the cure for superstition, is knowledge—knowledge of history, knowledge of the facts of nature and knowledge of the principles of human behavior. The Society of Sigma Xi, as well as the American Association for the Advancement of Science, which jointly sponsor this program, have as their great objective the promotion of that accurate and systematic knowledge which we call "science."

I believe that the service of Sigma Xi in the universities of the future will be determined by the opportunities and needs for the development of science itself, and I will proceed therefore to examine the nature of the service which science itself may be called upon to perform.

The rôle which science has played in social progress is nowhere more succinctly set forth than in the preamble to resolutions adopted by the American Association for the Advancement of Science, and submitted to the President of the United States in December, 1934:

"*Whereas,* Development and application of science have been basic to the economic and social progress of nations, making possible such movements as universal education, abolition of child labor and slavery, emancipation of women, insurance and pensions, moderate hours of labor and great improvement in the standards of health, comfort and satisfaction in living; and

"*Whereas,* Scientific developments have not only conferred general benefits, but in particular have been largely effective in leading to recovery from previous depressions—as the railroad industry following the depression of 1870, the electric industry following that of 1896 and the automobile industry following that of 1907; and

"*Whereas,* Scientific research is a productive investment proven by experience to yield a high rate of return, as illustrated by the saving of $2,000,000,000 per year from the Bessemer steel process and of over $1,000,000 per day from the modern incandescent lamp, and as illustrated also by the entire chemical, electrical, communication, transportation and metallurgical industries and by the enormous employment in such industries;—."

That our national health, prosperity, pleasure, and indeed our very existence, depend largely upon science for their maintenance and their future development, no informed person would deny. Within our generation this truth has been emphasized, for we have come to the end of free expansion by migration westward, and of free exploitation of ever newly discovered resources of soil and minerals. We have reached the point beyond which further increase in our wealth, population, physical comfort and cultural opportunity will depend not on discovering new resources by geographical exploration but by wiser use of the resources that we now have, through scientific exploration.

This idea is not new, but I doubt if we realize its profound significance; it marks a turning point in the history of the world! How did the Egyptians, the Greeks and the Romans secure their wealth? By the plunder and taxation of conquered nations and by "labor-saving" production through the work of enslaved peoples. How were the great commerce and wealth of England acquired? Through geographical exploration, conquest and colonization of virgin lands with such returns in wealth as we find it hard now to comprehend. For example, the profits of the British East India Company were of the order of 100 per cent on each voyage of its merchantmen.

Now all livable portions of the world are settled and closely interconnected by travel and trade. Probably the Italian conquest of Ethiopia and Japan's expansions into China are about the ending of the centuries-old struggle for wealth through territorial conquest. In our own country, Horace Greeley's advice "Go west, young man, go west" no longer has its original significance. The geographical pioneer is now supplanted by the scientific pioneer, whose thrill of discovery or urge for reward is no less keen and whose fields of exploration are probably unlimited. Without the scientific pioneer our civilization would stand still and our spirit would stagnate; with him mankind will continue to work toward his higher destiny. This being so, our problem is to make science as effective an element as possible in our American program for social progress.

Practically all scientific work in the United States is carried on under one or another of three auspices: The government, industrial organizations, and educational institutions or similar altruistic foundations. The scientific services of the federal government are spread through forty bureaus, of which eighteen are primarily scientific. There are about 630 colleges and universities in the United States, including 155 engineering schools. There are upwards of 1,600 research laboratories operated by industrial companies. Watson Davis, of Science Service, recently estimated the total annual national expenditures in scientific research work as about $100,000,000, divided roughly equally between government, educational institutions and industry. Each of these three categories of scientific work has its proper scope, limitations and opportunities. Each has its peculiar problems of operation. I will proceed, therefore, to discuss them separately.

SCIENCE IN GOVERNMENT

During the two and a half years of its existence, terminating last December, I had the extraordinary opportunity to serve as chairman of the Science Advisory Board, under which, with its subcommittees, more than a hundred of the country's ablest scientists and engineers gave free and devoted service to the scientific interests of the government at the request of the President. Out of this experience I could draw a kaleidoscopic picture of the scientific work of the government: work of vast importance to the welfare of the country; staffed by an army of able scientists singlemindedly devoted to their respective jobs; financed by less than half of 1 per cent of the total governmental budget; replete with duplicating and uncoordinated effort; subject to the charge that many projects are started but few are ever stopped; with partisan loyalties to bureaus and departments continually blocking attempts at changes in organization even when there is no disagreement as to the improved efficiency that would thereby be gained; with almost no executive officers, more permanent than the current administration, to coordinate the various bureaus, direct their programs and plan their future; yet with sincere and often courageous concern on the part of department secretaries for the efficient working of the bureaus under their jurisdictions; and under all these conditions a surprisingly effective service; these are some of the facets of this kaleidoscopic picture. (In these remarks I except the two military departments, which are organized on a more permanent basis.)

This is not the occasion to discuss the specific problems which were referred to the Science Advisory Board—which were technical problems of organization, scientific programs, budgets, or personnel. Suffice it to say that there was generally good cooperation from high officials from the President down and that there was much actual accomplishment, reflected in the present and pending operations of a number of the scientific bureaus, despite regrettable failure to achieve results in some important matters. But of greater significance than these specific jobs, was the development in the minds of the Board of a certain conception of the rôle of the government in science which I cannot present better than by quoting certain passages from the final report of the Science Advisory Board to the President:

"An absolute prerequisite to (our national) welfare, independent of political theories and basic to attempts at national planning or improvement of any kind or degree, is adequate scientific information regarding the materials and forces with which great groups of our population have to deal. This is the justification for the existence of scientific bureaus in the Government.

"In a democracy like ours, designed to safeguard personal liberty and to stimulate individual initiative within the framework of 'general welfare,' there is no need for the Government to embark upon comprehensive programs in pure science, invention or industrial development. There are, however, numerous scientific services of such wide scope and universal utility that no agency except the Government is competent adequately to handle them. (In this category are public health, weather forecasting, topographic mapping, development of scientific and technical standards, mineral surveys and statistics, safety codes, patents, soil science, improvement of crops and live stock). There are other scientific services which are essentially supplementary to non-scientific governmental activities. (Among these are engineering work relating to flood control, water supply and aids to navigation; scientific aids to national defense; development of standards for the purchasing of supplies for use of governmental bureaus.) There are also fields of scientific or technical development which hold evident promise of benefiting the public but which are not proper or practical fields for private initiative (such as the activities of the National Advisory Committee for Aeronautics, and the financial aid to land-grant colleges for development of agriculture and engineering arts). In these three categories and in this order of importance lie the proper scientific activities of the Government.

"The first scientific bureaus to be established had to concern themselves but little with the coordination of their programs. Each filled a definite need and its purpose was to gather facts in a designated field. (These federal services, however, have expanded enormously with the increasingly complex demands of our civilization.) Side by side with the growth in the number of bureaus and in the multiplicity of their functions, there should have been applied (more rigorously) the principle of coordination of related work, no matter in what bureaus the work may be done. (This is a primary requisite for efficiency.)

"Freedom of scientific work from political or policy-making influences is a second prime consideration. Whatever the trend of social or political thought and whatever the degree of national planning, the people of the country have the right to expect that the scientific services are always free to report and interpret the facts in a given field of enquiry as they find them and not as the government of the day may wish to have them reported or interpreted. (They) should be free to produce results that are not discolored by the opinions and snap judgments of policy-making political groups who may wish to put the dignity of 'science' behind their plans in order to win public approval.

"Over and above the work of particular scientific bureaus, there is increasing activity on the part of the Government in undertaking large projects whose feasibility or justification are matters for technical decision from many points of view: scientific, economic, humanitarian. Examples of such projects are: irrigation, power development, flood control, soil erosion control, shelter belt, waterways, retirement of sub-marginal land and colonization. Where huge sums are involved and large groups of people affected, it is more than ever necessary that decisions and policies should be settled only after the most thorough, competent and disinterested study of such questions as: Is the project technically feasible? Will it accomplish its purpose? What are the alternatives, and has the best plan been selected? Will the benefits justify the expenditure? For technical advice on such questions, Congress and the Executive Departments should have ready access to, and should use, the best talent available both within and outside of the government services.

"It is (therefore) the concern of every citizen that there be available to government the most competent and impartial advice which can be found. The endurance of our traditional form of government will depend in increasing measure upon the quality of expert judgment, tempered with experience, which is available to government, and the willingness of government to follow such judgment."

Considerations like these led the Science Advisory Board to recommend to the President the permanent establishment of a scientific advisory council, its members to be nominated by the National Academy of Sciences and to serve without pay, but with provision for necessary travel and secretarial expenses. This council would be enabled to appoint subcommittees on the principal scientific bureaus. The duties of this group would consist, first, in assisting the bureau chiefs to formulate general programs and policies; second, in promoting coordination and working against improper duplication of effort of the various bureaus; third, in interpreting, criticizing or defending the work and plans of the bureaus before the responsible department secretaries and congressional committees; fourth, in giving to the director of the budget its critical and independent judgment (advisory only), regarding budgets and requests for appropriations for scientific work in the non-military departments.

It is my conviction, shared by my engineering and scientific colleagues who have studied the situation during the past three years, that some such plan would be feasible, and that it would do more to increase the efficiency and the prestige of the federal scientific services than can be achieved in any other way. It may be that thought of such an independent and sometimes critical advisory service is not relished by any official who is more concerned with maintaining his unlimited authority than with ensuring efficient conduct of the people's business for which he is responsible. But when I heard a high official say that "of course the plan is impractical," I thought to myself that this only means that he and some of his colleagues do not like it. Plans similar to the one here proposed have been in successful operation in several European countries in recent years. In Great Britain, for example, a group of the Empire's greatest

scientists act as official advisers to the privy council on all questions of programs and budgets for scientific work under governmental auspices.

SCIENCE IN INDUSTRY

Turning now to industry, we have no difficulty in defining its proper scope of scientific research: that type of research is justified which shows reasonable promise of producing better products, or desirable new products which can be made and sold with profit, or of reducing the cost of existing products. Within this simple definition, however, lies great scope for informed judgment, courage and skill in the decision as to "what constitutes reasonable promise?" and "how great is this promise in comparison with the probable cost?" It is the action on such questions that largely determines the future growth or decay of an industry.

Experience has convinced progressive industries that as much as several percent of income can profitably be spent on research. This expenditure is both an investment for future dividends and an insurance against future loss through obsolescence or more enlightened competition. Dr. Robert A. Millikan emphasized the investment aspect when he said "Research pays because you know what you want, go after it with informed brains by the scientific method, and in general get it: but it often yields (extra) dividends because you get something more that you didn't go after." And Francis Bacon, over 300 years ago, described the fate of the industry which neglects research when he wrote: "That which man altereth not for the better, Time, the Great Innovator, altereth for the worse." The statement is not unusual which was made a few years ago by the president of a great manufacturing company when he told his stockholders that 60 percent of sales that year had been of products that ten years before were unknown.

Several years ago the National Research Council compared the financial health of industries, as a function of their activity in research, as measured for example by relative expenditures for research. At the top were such industries as the chemical, electrical, communications and automotive; toward the bottom were railroads, lumber and textiles. The correlation between support of research and financial prosperity was decidedly striking, and has been an effective object lesson.

In any attempt to make science more effective in industry and through it more helpful to the public, certain obstacles must be met and overcome.

First I would mention the so-called "hard-headed practical business man"; a man without vision, imagination or enthusiasm for new things; a man who scoffs at theory or a college degree; a man whose sole criterion of proper practice is that which he has been accustomed to in the past; a man who spends as little as he can on research in order that his profits day by day may be larger. The withering policies of such men have driven many a flourishing business into obsolescence. If, by accident, a research laboratory has been set up in this man's company, its staff will be among the first to be fired in a depression, thus saving temporarily dollars but losing permanently the capital investment in trained intelligence.

In this same class I would place that type of control, sometimes exercised by a financial group, which focusses attention on the profits of the current year to practical exclusion of developing strength for the future. I see many examples of this, in which the organization has become so weakened by the time it sees its mistake that it has not the strength to embark on a different course, and therefore continues to become sicker and sicker. One species of this type of business anemia arises when the cost accountant becomes the master instead of the servant—applying cut-and-dried methods of evaluation, on a monthly or yearly basis without discrimination and without realizing the values which may reside in a research, a big idea or an active brain.

From these two examples, which I have purposely stated strongly, you may infer that I advocate the growing tendency to give technically trained men an increasing share in the management and policy-making activities of industry—and I do not mean to infer that financially trained men are not also essential.

A second obstacle is the cost, delay and uncertainty in the operations of our out-moded patent procedures. This is one of the major hindrances to the development of new industries and the supplying of new employment through the results of science. It is greatly to be hoped that favorable action will be taken by Congress on several recommendations by the Science Advisory Board aimed at increasing the presumptive validity of patents and the accuracy and ease of decisions by the courts.

A third obstacle is found in the increasing regulatory activities of the government for the stated objective of protecting the public, but sometimes in the nature of disastrous boomerangs. I believe that an increasing degree of regulation of business for protection of the public is a necessary accompaniment of increasing general complexity and competition. But this regulation should be benevolent and intelligent, two characteristics which are not as prevalent as they should be. A fundamental difficulty appears to reside in the fact that in general we are governed by politicians rather than by statesmen. By this I mean that our elected rulers are generally men of alert perception to public opinion, nimble in debate, persuasive in oratory and skilful in dealing with group psychology; but these excellent qualities do not necessarily fit them to make wise decisions in such questions as: What technical procedure of subsidies, or curtailed planting, or research to create new industrial uses for his products, will best help the farmer and at the same time the country as a whole? or, Is a public utility company justified in charging on its bills to today's customers part of the cost of research designed to improve or cheapen the service to tomorrow's customers? These are profound questions, which greatly affect the ability of science to promote our social welfare. Our present method of deciding such questions is frequently expensive, illogical or ludicrous and is sometimes disastrous. However, while recognizing this difficulty, I can offer no solution to it and am unable to prove that we do not have the best of all possible types of governments in the best of all possible worlds, in the long run. Thus I will mention the government no more except to point out that its present attitude toward both industry and science is in unflattering contrast with that of several European countries which have helped industry in a positive way by offering it definite

incentives to embark upon a more active program of scientific and industrial research, considering this to be a national investment for future prosperity and employment.

SCIENCE IN EDUCATIONAL INSTITUTIONS

In educational institutions, science has no limitations in search for truth except those imposed by availability of ideas, workers, facilities and funds. Such institutions have always been the places where the great bulk of new discoveries are made and ideas born, and this will continue to be so since there exist no other organizations where such studies can be similarly pursued. The practical aims of educational institutions in science are well described by Dr. Isaiah Bowman: "The trade school exists for the admirable purpose of putting practically trained men into jobs; the university exists, among other things, to create and expand the sciences that provide the jobs. It is in engineering that these two points of view are effectively joined."

The fact that the universities and engineering schools do feed industry with most of the new ideas, which industry then transforms into products of social value, was illustrated by Dr. Roger Adams in his recent presidential address before the American Chemical Society when he said, "The basic and fundamental information for over 95 percent of the industrial processes has been originally discovered and described by the university investigator." I recall a statement written by Herbert Hoover, when he was Secretary of Commerce in which he expressed concern lest the industrial supremacy of America should be lost because our industrial leaders were not actively enough concerned with laying the foundations for the industrial future by strongly supporting pure scientific work at the present time. Mr. Hoover not only believed this but he worked to bring about increased support of pure science by industry until the presidency brought him new and greater problems.

Growth of industry and employment, and gain in civilization through science are like the growth of plants in Nature: of many seeds which are scattered, only a few grow to be vigorous plants; but if no seeds were produced and scattered there would be no plants at all. Scientific discoveries are the seeds of industry and public welfare, and the universities are the nurseries in which they are produced and nurtured to the point where some of them can be transplanted into the fields of industry. I once likened new industries to babies—they need shelter and nourishment, which they take in the form of patent protection and financing. But, before all, they need to be born, and their parents are science and invention. Neither laws, nor committees, nor juggling acts, nor wishful thinking can perform the first necessary step of conception. To maintain and advance our civilization we need more and better scientific seeds and industrial babies. The educational institutions of higher learning are the birthplace of this new knowledge, as well as the training and proving grounds for the young men and women who will carry this knowledge on and put it to practical use.

In discussing this matter with my friend, Dr. Charles F. Kettering, a couple of weeks ago, he expressed the opinion that one of the major problems of both

industry and the universities is to facilitate this production and nurture of the seeds of industrial progress, in the universities, and to narrow the gap and hazard between discovery and successfully launched business. To do this requires closer cooperation between industry and educational institutions, involving more active research programs in the institutions, their more general financial support by industry or by the captains of industry, and closer personal contacts between the men in the two groups who have related interests.

My own observations of what can be accomplished in an educational institution like the one which I represent convince me that there are really great opportunities along these lines. I have seen the sprouting of literally hundreds of promising ideas; I have seen the cooperative effort of professorial chemists, physicists, electrical engineers and metallurgists solve serious industrial problems that had baffled the skilled practical men of industry; I have seen a little of the desired financial support; and I have seen productive mutual stimulation in such cooperation. As I see it, a great university or engineering school already possesses, because of its teaching responsibilities, the principal overhead of staff, facilities and administrative organization necessary for a large research program, so that relatively large returns in the fields of research and development can be secured with relatively little additional financial support. It is in this direction that there lies, in my judgment, the greatest opportunity for increased contributions to public welfare through science in the leading educational institutions, and thus far the surface has only been scratched. I believe that, with more adequate financial support, a new order of institutional public service will be possible.

One peculiarity of scientific research is that its results can usually not be foreseen, for if they could be foretold they would not be new. Also, when a new discovery is made, it is not usually immediately obvious as to the possibilities of its practical uses. And again, the solution of a scientific problem may be a long, hard struggle—longer than was realized by a visitor who asked Harvard's President Conant what he was doing in his laboratory. When Conant replied, "We are seeking to discover the chemical formula for chlorophyl," his visitor exclaimed, "Why, how is that? You were working on that problem when I was here last year!"

Because of these uncertainties I cannot tell you just what the next big scientific developments will be, but I can assure you that they will come and that they will be important. Among the fields that seem to me to show especial promise are: development of new industrial uses for farm products; improvements in transmission and utilization of electric power; great developments in materials and methods of building construction; increased range and precision of weather forecasting; conquest of hitherto unconquered diseases, both physical and mental; better regulation of bodily functions; a new era in biological discovery operating with the tools of physics, chemistry and engineering; a similar new era in physical science centered around atomic nuclear transformations; and so on, the field is literally limitless.

To all of these problems in government, industry, universities and altruistic foundations, the present and future members of the Society of Sigma Xi will

make their contributions. These contributions will be effective in some such proportion as the members themselves have a real grasp of the range and significance of these problems and through this grasp have confidence and enthusiasm for the contribution which they themselves may make through their scientific work. For this reason I believe that the Society in its programs should, from time to time, review the progress and the opportunities of science in the various large categories of activity such as government, industry and pure research. I am convinced also, on the basis of experience in the last few years, that there is tremendous room for effective missionary work for science in convincing the public, and particularly the leaders of the public, of the values of scientific work. In some cases this conviction can be made by argument, but in general it is likely to come only through the sympathetic interest of the public and this means a great program of mass education.

For this reason I believe that one of the major duties of the members of Sigma Xi is to be sympathetic with and to encourage the proper type of educational publicity through which the public can be informed and interested in science. A good deal of progress has been made in recent years toward overcoming the instinctive prejudice of the scientist against having his work publicized. A certain balance in this matter is necessary, but the more I see of those conditions which determine the degree of opportunity for scientific progress, the more I am convinced that the scientist has just as great an obligation to maintain friendly and understanding relations with the public as he has to operate with skill and devotion in his laboratory.

Having thus suggested a few of the more significant ways in which science or this Society may be made to contribute more effectively to our social progress, through the agencies of government, industry and education, I close by saying that the greatest of all contributions of science is not found in the comforts, pleasures or profits which flow from it, but in the freedom and imagination which it has brought to the human spirit and the sense of relationship and unity in the world. Of all descriptions of the true spirit of science I like best the words of the ancient Greek philosopher, Aristotle, which appear engraved on the beautiful home of the National Academy of Sciences in Washington: "Search for truth is in one way hard and in another way easy, for it is evident that no one can master it fully nor miss it wholly, but each adds a little to our knowledge of Nature, and from all the facts assembled there arises a certain grandeur."

THE RECEPTION AND DINNER

The delegates to the Semi-Centennial Celebration from chapters and clubs learned societies, and visiting scientists, about seven hundred in all, were guests of the Cornell Chapter at a reception and tea in Willard Straight Hall in honor of the founders and at a semi-centennial dinner. The long line of guests at the reception were presented to the founders by President Durand and refreshments were served by a committee of faculty women under the chairmanship of Mrs. K. M. Weigand. The dinner was served on the terrace and in the

dining hall of Willard Straight Hall. The number attending exceeded all expectations. The hospitality was large and generous and cordial, and the arrangements for the care of all the guests were adequate and carried out to perfection. The chairman of the committee on the dinner was Prof. H. H. Whetzel of the Cornell Chapter.

THE FRIDAY EVENING PROGRAM

The large theatre in Willard Straight Hall was scarcely adequate to accommodate the audience which gathered at nine o'clock Friday evening for the fourth part of the Semi-Centennial program. On the stage were three founders of Sigma Xi, and officers of Sigma Xi and of the Association for the Advancement of Science. President Conklin of the Association presided and introduced the speaker, Dr. Max Mason, president of the Rockefeller Foundation.

MAX MASON

SCIENCE AND THE RATIONAL ANIMAL

The celebration of one's birthday, after a certain age, is probably sound psychoprophylaxis, but can hardly be met with unmixed feelings, even though "The Old Gray Mare" is not made the theme song of the occasion. One does not wish to be reminded of the passing of the milestones on a journey that is short and filled with interest and happiness. In early youth, however, the view is all to the future. At sunrise the mind and heart are absorbed with the joy of planning the day to come.

We are met to celebrate the fiftieth birthday of Sigma Xi, an institution which need never grow old, and which now, on the time scale of the history of the race, is an infant drawing its first breath. Our interest tonight is in its meaning for the future rather than in its brief past—its meaning as a symbol of the devotion of countless thousands and of countless millions to come to the life of science and to their faith in the scientific way of life. These are not mere phrases. There is a life of science in which we are united by fellowship in effort. There is a scientific way of living, and its attainment is the aim of all the sciences.

In accurate scientific knowledge there *is* power—power, as has been amply demonstrated, to release man from physical drudgery; power to release man from fear, that child of uncertainty, as he learns the story of the universality of natural law; power to determine his destiny as he understands himself to be a product of evolutionary processes and learns the psychological and physiological factors which condition his personality; power to give him peace and courage for life in a friendly universe as he partakes of "the sweetness and glory of being a rational animal."

Whatever be the momentary problems of a troubled world, only the mistake of confusing the eddies in the rushing stream of human progress with the main

current can lead to pessimism. It must be remembered that it is the sluggish stream which has no eddies. The Society of the Sigma Xi is only fifty years old, yet its life period is one-sixth of the whole time since the advent of the new learning. It is only three centuries since Galileo dared to find facts; dared to dispute the authority of Aristotle and to challenge the stifling power of organized superstition and mysticism. Man has been released from his fear of finding the truth regarding the behavior of physical forces. Only today is he overcoming his fear of finding the truth about himself, only today is he gaining faith in the applicability of the scientific spirit and method to the great problem, the problem of the distortions and difficulties that cripple the human intellect and the human spirit, retard the progress of the race in social organization and control, handicap man in his human contacts and in his individual performance, and violate the greatest of human rights, the right to be formed as a personality to the highest degree of intellectual and emotional power and stability which is consistent with his inherited organism. Through steady, patient accumulation of exact knowledge man has reached so far that he can at least perceive the course to be followed in his struggle for self-control. He has learned that control comes through understanding and that understanding derives from that patient and objective search for truth which is known as the scientific method. As he applied the method in daily life he promotes the rationality of line. As he derives and applies fundamental knowledge to the life processes, mental and physical, he gains power to control the growth and development of the individual and of the race.

Throughout the centuries man has pursued his quest for understanding and control. His efforts until the new learning were, except for short brilliant periods, crude and naïve. His strivings passed on a mixed heritage to the following generations. We can imagine the awe and wonder with which, before the dawn of history, he studied the stellar groups sweeping across the sky, and the glowing planets threading their way among the stars. The life-giving overflow of the Nile occurred with the appearance of certain constellations in the evening sky, and so may have arisen the belief that human lives are ruled from the heavens—a belief which promoted astronomical observations, but burdened man with a heavy load of superstition and mysticism. So eager was his desire for causes that a few coincidences determined unjustifiable beliefs which lived for centuries and renewed his store of superstitions.

The spirit of the new learning came into immediate conflict with the church. An organization based upon the belief that final truth had been revealed to man by supernatural means was compelled to resist the findings and aims of scientific searchers. The great religions had been so distorted from the simple teachings of their founders that many of the acts of their organizations and members were heart-sickening examples of cruelty and inhumanity although performed in the name of a religion dedicated to the idea of the brotherhood of man. There has never been and cannot be any conflict between the aims of science and the spirit of religion, but the spirit of religion did not enter into the minds of those who lived for the passionate defense of the dogmas of a sterile theology. So man fought for emancipation from the chains of his own making, after the

centuries during which he had remained bound to the Aristotelian milestones of his former progress. The familiar story is always new, always inspiring. As accurate knowledge was gained of the physical behavior of matter the tools of mathematical analysis were developed and applied to gain simplicity of description and unifying concepts. In the lifetime of Sigma Xi the separate chapters of physics have become one, chemistry and physics have merged, and the knowledge and methods of beautiful accuracy and refinement in those fields have been brought to bear on the involved and difficult problems of the life processes.

Using the vast library of scientifically determined facts and concepts, the engineer and the inventor have revolutionized the mechanical surroundings of civilized life, speeding up to an almost incredible degree transportation, the interchange of intelligence, and manufacture, but the resultant close coupling, within nations and between nations, of economic processes has greatly intensified the difficulty of economic stabilization. The changes have all tended to intensify the fluctuations of the economic system, a machine which shows the phenomenon of "hunting" produced by the inertia and time-lag of its governing mechanisms. The stresses on our social and political life which are thereby produced are ominously great, and solution waits upon the ability and willingness of man to learn and to apply control measures and to adopt a new business ethics based upon the mass implications of individual action in the present world.

It has become a commonplace to state that man's control over the physical forces of nature has outstripped his control of himself. Technology has given him intoxicating power, and some of the results are not surprising. I have no desire to attempt an estimation of those material changes in our lives which are usually termed progress, or to attempt a judgment of their effect on the well-being of man. Much must be entered on the wrong side of the ledger. The quiet and peaceful valleys of the countrysides now echo to the roar of trucks. Flaunting signs, unsightly gas stations and dog wagons affront the eye; and that marvel of modern engineering, the radio, spreads throughout the land inanities which are listed under the title of humor, and exposes with pitiless fidelity the adolescent hysteria of political conventions, met to discuss the government of our country.

However significant may be the present and future rôle in civilized living played by the technological applications of physical science, this is far from the significant and basic meaning for man of the scientific method. His real problem is himself, and a new chapter in the life of man has been opened by the realization that three hundred years of scientific effort have taught him the method and brought together a vast collection of knowledge of techniques for the study and control of human development and behavior, and arrived at a conception of man as a psycho-biological organism governed by regular behavior patterns both physiological and psychological, which may be analyzed and controlled.

Such a thought would have been impossible a few centuries ago. Man was conceived as heaven-born, fixed, a thing apart from the rest of the organic world and not a product of evolutionary forces still in the making. It was impious to

study even his dead body, that lowly and ignoble thing which only housed his mind and his soul.

The recognition of man with all his characteristics and behaviors as a psycho-biological entity is one of many examples in which a deeper insight shows the essential unity of concepts previously considered as separate and even antagonistic. To the Greeks theory was celestial and noble, practice and experiment were terrestrial and ignoble. It took us many decades to see the unity between beauty and utility—to discredit art in a vacuum and to understand that concepts of beauty and grace are idealized from bases of efficiency. Scholarship removed itself from the life of reality. Business and philanthropy were put at opposite poles. Performance was divorced from education. Educational institutions introduced special personnel to be kind to students, relieving thereby the regular faculty from that obligation. The list is endless.

But to return to our theme. The irritability of the unicellular organism gives the response mechanism for self-preservation. In higher evolutionary forms a diffuse nervous system admits of more complicated reactions, and from it has evolved the central nervous system of the vertebrates. The brain is the organ of greatest change as we pass up the evolutionary scale, the spinal cord and sympathetic nervous system remaining much more constant. The higher the forms the more complicated are the possible reactions to external stimuli, the more adaptable the organism to novel conditions. *Homo sapiens,* with his great power of association, rapidly became the dominating vertebrate. His responses to stimuli were determined by no mere set of reflexes. When met by a set of circumstances he could delay his response, and determine his action by the complex procedure we call "thinking things over." In imagination he could follow a series of possible courses of conduct, and find the one to please him. He calls the result "logical," and the process "rational." He probably means that the associations and memories of past experience, both real and vicarious, awakened by the pseudo-experience of his accepted plan for conduct call forth a greater glow of pleasure than those produced by other plans. As his civilization developed, "thinking things over" became an ever-increasing part of his activity, creating an enormous difference between his life and the life of even his nearest evolutionary relatives. But even if he lives an "intellectual life" man remains an animal. The neuro-physiological processes of his cerebral cortex remain geared to those of the thalamus, to the entire nervous system, to the endocrine glands, and to his whole anatomy.

The marvelous powers of his complex organism have made him in truth the master of his physical environment. In his evolutionary progress he may have lost much, but so content is he with his extraordinary mental ability that he does not regret it. He has lost his fur, and is afraid to sit in a draft, but he can make air-conditioned rooms. His children at birth are helpless, with almost no inherited action patterns, of any complexity, but they are the more capable of conditioning. He is peculiarly susceptible to infectious diseases, but he is confident of his ability to control and in the long run to eradicate them. Judged by his power over the physical circumstances common to all organic life, the highest evolutionary product is, by virtue of his highly developed central nervous

system, a complete success. But this is not all of the story. The use he makes of his nervous system has enormously changed in character as he has emerged from savagery—a time too short for the processes of evolution to follow. He has created a new manner of living, and a new environment—a social environment—with whose problems he must wrestle. *Homo sapiens,* in his early days, hunted, fought and fled much as his evolutionary forebears had done. He was a man of action, and the action was physical and immediate, though determined with insight and cunning. His emotions played the natural rôle of intensification of the physical effort adapted to the circumstances, stimulating the liberation of hormones, which in turn reacted on nervous system and muscles. Today civilized man lives a mental life, thought and still more thought, that complex process of pseudo-experience, calling into action both consciously and subconsciously, the countless associations formed throughout his life, with their emotional responses. The whole organism partakes of the process, but the primitive type of response to the call of neuropotentials and hormones does not occur. Anger is a valuable emotion for the savage, determining quick and forceful action, but it is a poison to objective and rational thinking. In modern life the hormone response to this and other emotions, and all the chemical changes which organize the body to meet an emergency do not find their normal primitive use. It is not surprising that the biochemical imbalances thus produced disturb the normal physiological behavior of the body and are responsible for much disease with definite pathology in modern life. The gastrointestinal disturbances were perhaps the first in which the psychogenetic factors were clearly recognized, but the list is an ever-growing one.

The disturbances of physical health which occur in the struggle of the complex and delicately balanced human organism to adjust itself to its self-made and continually changing environment are however of minor importance. We live for, and prize the fruits of the human intellect and spirit. Disturbances of mental health strike at the very center of our existence, undermining individual happiness and effectiveness, social organization, and control of our evolving civilization. Judged only by the cases of frank and disabling mental disorder, the casualties in the evolutionary struggles of man give a staggering total. As many hospital beds are used for mental disorder in the country as for physical illness. But even this is not the heart of the matter, and does not give the real picture, any more than the visible light from the sun gives the whole spectrum of its radiant energy. For every case of frank mental disorder there may be a score of borderline cases, a hundred lives of great unhappiness and low efficiency due to mental maladjustments, and millions heavily handicapped by distorted mental action patterns and emotional instability.

It seems clear that the gropings of man to understand the nature of the world and of himself lead to a recognition of his basic responsibility and problem. With his mind partially freed from the misconceptions and taboos of the past, he can view himself as a psychobiological unit in the organic world, with mental action patterns formed and conditioned by his experiences. To have arrived even as far as this is enormous progress. But we have gone much farther. Recent years have seen an ever-increasing application to the basic problem of

human life, of all the methods, detailed techniques and vast stores of the exact knowledge of science. Man's greatest intellectual achievements are being focussed to resolve man's greatest difficulties. The vital problem is being attacked by the Great Method. We could not ask for more.

I should like to look at the human behavior problem by using an analogy. Analogies are dangerous, but offer a tempting refuge for one whose interest and enthusiasm for the work of this field is not hampered by the possession of exact knowledge in it, and who cannot forget the words of Alice in Wonderland, "I could explain this better, if I understood it myself."

Suppose a great number of automobiles were given to a completely isolated group of people, who had no knowledge whatsoever of an automobile, and a rudimentary knowledge only, of simple mechanical actions. They would surely be agog at the occurrence and would waste no time in getting at the mystery of their operation, each according to his way of problem-solving. Many would begin to push and pull everything in sight, the more intelligent proceeding according to system and keeping record of their experiences. Another group would certainly begin to take their automobiles apart, their investigation following a logical course as they traced the connections of wheel to differential, to shaft, transmission, clutch, and engine. A member of the first group, Mr. A., seeks generalizations which may lead to understanding enough to drive the car. A member of the other group, Mr. X., seeks detailed understanding of the whole mechanism. Undoubtedly A. will first drive a car—he would beat X. by years, and perhaps decades. Before long, pressure on the starter will start the engine—and from that point progress will be rapid, until the car can be used. Mr. X. will be more of the temper of the pure scientist. He will insist that the only way to proceed is to gain detailed knowledge of every part. He will not think too highly of the progress of A., even when he exultingly drives past him, and he will not relish A.'s irritation at the slow progress of his microscopic methods. But before long, cooperation will become inevitable, for A. will have trouble. X. may have a poor picture of the operation of the car as a whole, and no skill in driving, but he may know much about clutches and understand why they slip, and his fellow specialist Y. may be just the man for ignition systems. The two methods of study are sensible and desirable. The more immediate results are gained from the more superficial general study. The combination of the two procedures gives adequate comprehension in the long run. Neither method is more "scientific" than the other.

One group of workers in the field of human behavior is searching for the major action patterns of the mind—for generalized coordinates. It is again in the lifetime of Sigma Xi that they have made great progress. Their search for correlations has uncovered the rôle of the subconscious in determining mental action, and given insight into the origins of those disturbing complexes which are so strong that they warp mental reactions over a vast range of associations. Study of the character and origins of disturbed mental behavior is giving insight into the normal, and into the determination of personality traits by the emotional experiences in the early years of infancy. Compelling and startling force is given to the thought of the responsibility of each generation for the well-being

of the next. The concept of the average human as a rational being emerges considerably battered, as we understand something of the subconscious emotional carry-over of past experience. We shall have to admit that each individual has at best a conditioned rationality. But this is real and great progress, for it compels an objective attitude of man to himself, a search within himself for the existence and causes of his own prejudices, a sympathy and understanding for the prejudices of others, and a deeper meaning to the responsibility of parent and teacher.

It is natural that the students of behavior, psychologists and psychiatrists, have their competitive and sometimes antagonistic groups and schools. The field is one of perplexing difficulty, the work is young. But valuable knowledge is always ultimately accepted, even when obtained by a school whose adherents antagonize others by the exaggeration of their claims and the narrowness of their methods. In a scientific theory, an analogy is set up between the end results of the interaction of stated entities obeying stated laws, with the results of observation. "Reality" of the entities, physical or psychic (whatever that means), is of no great moment. The analogy constitutes the theory, which is "true" or useful to the extent that it describes and correlates phenomena. Some of such theories may be of great value, even though they are manifestly very incomplete, and will probably be of short life. This is undoubtedly true of many of those now prevalent in both psychiatry and psychology.

In addition to the work of the psychologist and psychiatrist, that of the cultural anthropologist has been of great value, and has thrown light on the older narrow and naïve conceptions of the intrinsic patterns of human behavior—of so-called "human nature."

Thus are Mr. A. and his colleagues seeking for new knowledge, and applying the present store to the difficult problems of psychotherapy and mental hygiene. Their insights are illuminating to the field of education and to general medicine. The interplay with the latter is very close. Many disorders have been moved from the heading "somatic" into "psychic," and *visa versa*. More fall under both headings. The distinction between "organic" and "functional" disease is losing its meaning, as more refined techniques of observation and study become available. The pendulum swings between the side of the psychological and the side of the somatic as new understandings occur—but cooperation between these instead of contest is now the word.

Our analogy with the A.'s and X.'s, like all analogies, breaks down very easily. There is a continuous gradation between these extremes. Over a score of separate scientific fields are represented in the behavior problem, each with an army of workers. New biophysical and biochemical insights are brought to the aid of the neurophysiologist. Mathematical treatment of neurophysiological action and of cell behavior, is making its modest beginnings, dealing first, of necessity, with highly simplified systems. The complicated rôle of the hormones and the interplay with the nervous system in health and in disease are being slowly unraveled. The difficulty is great, and makes impossible demands of the organic chemists, who are struggling ably to meet them. The advances in the whole field of the life sciences remind one of those in physics at

the turn of the century. But however fast they are coming, so sharply are they focusing on the problems of most crucial importance for man, that the layman hopes for even greater speed, his imagination fired by the vistas that are continually opening for further gains. The boundaries between some of the disciplines are being broken down, and at last men are training themselves for work at problems rather than for membership in departments, while cooperation between specialists of different fields is constantly increasing. The problems demand and should have the full support of the basic sciences, not merely their tools—for the viewpoint and type of curiosity of a physicist are as important in a problem on neural action or cortical potentials, as the oscillograph to be used.

Only a few of the possible optical, electrooptic and magnetooptic effects have ever been used in the microanalysis of body fluids, hormones and vitamins—to mention but one small subfield.

To pass in review the growth in knowledge and power of the life sciences, during the last few decades, is an inspiring experience. The conviction is gained that we have in them truly the beginnings of a Science of Man. The previous three hundred years have served the purpose of establishing methods, and preparing tools and techniques. A new chapter in the history of science and of man is beginning as all the sciences are brought into coordinated attack on the vital problems of his future.

Our civilization can advance as the art of living is enriched by the application of knowledge won through the sciences. But scientific and technical knowledge can be used to retard and even to destroy the things most valuable in our lives, if their use be distorted by prejudice, passion, or individual and group selfishness. The safeguard is to be found in proper emotional education, both formal and informal, for the attainment of self-control, and the acquirement of the objective attitude. These qualities are the essence of the scientific attitude, and characteristic of the scientific worker, when he is in his laboratory.

Those sciences advanced most rapidly for which the objective approach was most easy—in the fields remote from personal prejudice. The success of the method made its application possible in fields lying closer and closer to those in which man's rationality was more highly conditioned. Each success should give increased impetus to the process of the rationalization of life—to the application of the objective attitude and scientific approach in all the affairs of living. An especial responsibility for the furtherance of this process surely lies with the scientists who should so thoroughly appreciate its value.

Today wide publicity is given to new scientific discoveries and theories. There is no lack of public interest in the results of scientific research. I wish there were a corresponding desire to utilize to the full the simple lesson for life that the success of the scientific method teaches, and a compelling belief that the world could be made a different place if this were done.

The Society of the Sigma Xi is a brotherhood of those living the life of science. Let us imagine a new organization—a brotherhood, let us say Alpha Omega—dedicated to the scientific way of living. The possession of special scientific techniques is not necessary for membership in Alpha Omega. Its members believe in finding facts, they know of the stores of accurate knowledge

that have been collected by the objective search for truth in all fields of human interest. Some of them they can use themselves—for others they must rely on their fraternity brothers who have special knowledge. The password of Alpha Omega is the question "How do you know it?" followed by the question "What of it?" The Alpha Omegas are not universally popular, for they take an aggressive attitude to some of the foibles of their friends. They do this because they believe that little things add together to make large things, and that mental attitudes are contagious. They continually see small and apparently harmless examples of belief and action that remind them of the burning of witches, of lynchings, of cruel intolerance, of the K.K.K., of the Black Legion, of mass murder in the name of patriotism. And so they do not keep their passwords secret—they use them every day. They have many lighter moments that serve to keep them in practice. An Alpha Omega who plays bridge has many opportunities for this, and since one thing leads to another, may even gain a convert or two. His partners give up sitting on their handkerchiefs to change their luck. They know the difference between the statements that "the cards are running North and South" from "the cards have been running North and South." They learn to derive as much pleasure from exhibiting indifferences as to which deck they play with, as they used to gain in winning the cut and choosing the "lucky" deck. Fewer of his acquaintances believe that they are "poor holders" of cards, or that they always have been, and are to be, in general, unlucky, but this progress was probably gained at a cost and only after some discourteous remarks on mental attitudes to life. After some time, the friends of our Alpha Omega begin to see some system in his peculiar conduct in what they judge to be small matters, and if so the leaven is working. They no longer recite as a fact a tale of a man's hair turning white over night, but instead have learned something regarding credulity and a bit of physiology. The universal belief in the old-fashioned winter has been replaced by an appreciation of the reasons for such beliefs and perhaps a little interest in climatology. The family legend of Uncle George, then a thousand miles away, appearing to Aunt Susie, is no longer heard. Perhaps an interest in the ability to describe an occurrence as it actually happened and to repeat this many times with fidelity, is gaining ground, and may make some headway against the interest in dramatizing an account. While our Alpha Omega hopes to keep his own emotional reactions under control, he lets himself go, when he meets the vicious cruelty of the male or female gossip. "How do you know it?" and "Well, how does *he* know it?" is a simple and effective weapon for decency and sanity. Unless there be shown some respect for the characters of our political leaders, we can hardly expect their ranks to be recruited from decent men. Our Alpha Omega has a hard time during a political campaign.

We cannot be true to the spirit of science in our laboratories and false to it in our lives. We cannot have faith in the rationalization of life without seeking to promote it. In that effort we must not overlook the obvious because it is so simple. We cannot follow the example of the Common Council, which, by motion, resolved: "That the Fourth Ward Marsh be, and it hereby is, drained."

Members of Sigma Xi and friends, I invite you to membership in the Society of Alpha Omega.

THE SATURDAY MORNING PROGRAM

The spacious Baker Hall of the Chemical Laboratory was filled to capacity when President Durand opened the fifth part of the Semi-Centennial Program at ten o'clock, with the presentation of two Semi-Centennial Research Prizes of $1,000 each.

DOCTOR DURAND

THE PRESENTATION OF THE PRIZES

Members of Sigma Xi and Friends:

The first item on our program this morning comprises the agreeable duty of awarding the two Sigma Xi Semi-Centennial Research Prizes of one thousand dollars each; but before making these awards individually, I wish to state that the award of these prizes is intended to signalize in the most emphatic manner the corner stone of the edifice which we have erected during the past fifty years—present achievement in research and the promise of better things to come.

The instructions framed by the Executive Committee and intended to govern the selection of the recipients of these awards, stipulated that the awards should be given to research workers in science who might still be considered young, *i.e.*, that the field of choice should comprise those already engaged in research and with notable work accomplished, but who might not be considered as yet having arrived at the full measure of their stature in science. In brief, it was intended that the awards should be made as a stimulus to research in progress and in the future, rather than as a reward for past and completed achievement.

All the chapters and clubs of Sigma Xi were asked to name one candidate for each of these awards, and to accompany their nomination with a statement of the project upon which the candidate is at work, together with supporting letters from three prominent scientists who are acquainted with the candidate and with the importance of his project.

There was a total of eighty-five different candidates—forty-three for the physical sciences, and forty-two for the biological sciences.

The committee appointed to undertake the task of examining and weighing the evidence presented in favor of these candidates comprised the following names: Dr. Harold C. Urey of Columbia University, chairman; Dean J. W. Barker of Columbia University; Dr. W. B. Castle of the Harvard Medical School; Prof. George A. Baitsell of Yale University; and Prof. Edward U. Condon of Princeton University. This committee has carried out its work in the most admirable fashion, and I wish at this time to give expression of our appreciation and gratitude for the painstaking and careful way in which they have discharged the duties entrusted to them. It was no small task to examine critically and to weigh with judicial fairness the evidence presented. By the way in which they have carried out this work they have placed the Society

Dr. Richard E. Shope

Rockefeller Institute for Medical Research, Princeton, New Jersey
Winner of Sigma Xi Semi-Centennial Award
in the Biological Sciences, June 20, 1936

Dr. I. I. Rabi

Winner of Sigma Xi Semi-Centennial Award
in the Physical Sciences, June 20, 1936

under an obligation which I can only in small part discharge by these few words of public recognition.

The committee held two conferences at which all members were present, and a subcommittee on the physical sciences, and a subcommittee on the biological sciences had several conferences each. The committee called into counsel numerous individuals other than the original sponsors of the candidates, regarding the ability of candidates and the importance of their work in their particular field.

This statement of the conditions under which these awards have been made will be a sufficient indication of the severity of the scrutiny under which the work of the two present recipients has passed and of the high order of merit which must have been put in evidence in order that they should have been selected from this wide field of choice.

And now it becomes my very pleasant duty to announce the award of the Sigma Xi Semi-Centennial Research Prize of one thousand dollars for work in the *biological* sciences to Dr. Richard E. Shope, of the Rockefeller Institute for Medical Research, Princeton, New Jersey, for the work he has done on the etiology of swine influenza—particularly for determining the dual nature of this disease, and thus establishing a principle which it is believed will have wide application in the control of infective diseases. Doctor Shope's discovery that swine influenza is caused by a filterable virus and a bacterium, neither of which could produce the disease alone, has already led to other research work in similar human diseases and one result is the belief that the common cold is brought about by a virus-bacterium combination.

Doctor Shope was born in Des Moines, Iowa, December 25, 1901. He received his M.D. degree at Iowa University in 1924. He was instructor in pharmacology and materia medica in the college of medicine at the University of Ohio for one year, and has been at Rockefeller Institute since 1925. His particular work has been in the field of animal pathology and filterable viruses.

Doctor Shope, it affords me very great pleasure, on behalf of Sigma Xi, to hand to you the substantial evidence of this award and to wish for you a long and fruitful life in the further pursuit of scientific research in your chosen field.

DOCTOR SHOPE'S RESPONSE

It would be impossible for me to adequately express to you how pleased and proud I am that you have honored my work in this way. The only thing I can say is that I sincerely appreciate it, and thank you very much.

DOCTOR DURAND

THE PRIZE IN THE PHYSICAL SCIENCES

The Sigma Xi Semi-Centennial Research Prize of one thousand dollars for work in the physical sciences is awarded to Prof. I. I. Rabi of Columbia University, for work which he has done on molecular beams, and on the magnetic

moments of the proton and deuteron. Doctor Rabi's research work deals with magnetic forces within the infinitesimal nuclei of the atoms, and his special fields are magnetism and quantum mechanics and particularly molecular beams. The prize is awarded to Doctor Rabi because of the results already achieved and because of the promise that this work holds for the future.

Doctor Rabi was born in Rymanow July 29, 1898. He received his Ph.D. at Columbia in 1927. He was a fellow in physics at Columbia for one year, and has been assistant professor of physics at Columbia since 1930.

And now, Doctor Rabi, it affords me very great pleasure, on behalf of Sigma Xi, to hand to you the substantial evidence of this award and to wish for you, too, a long and fruitful life in the further pursuit of scientific research in your chosen field.

DOCTOR RABI'S RESPONSE

I was overwhelmed, I must confess, when I received the announcement of this award, but now that the chairman has explained how careful the committee was, I feel reassured. It is difficult for me to express my deep appreciation of this award, and my feelings at the present time at receiving this on the Cornell campus where I first became acquainted with the work of Sigma Xi. The meetings and inspiring lectures which they held gave young men an opportunity to see and hear the greatest spirits in fields of science, and to receive inspiration from original sources. Thank you.

President Durand presented Dr. Willis Rodney Whitney, vice-president of the General Electric Company in charge of research, who gave the first formal address of the morning.

DOCTOR WHITNEY

THE ACCOMPLISHMENTS AND THE FUTURE OF THE PHYSICAL SCIENCES

INTRODUCTION

The promising study of mankind is man. I want to direct your thoughts with that in mind, under the title, Accomplishments and Future of Physical Sciences.

This means a hurried view of a lot of territory with an eastern horizon at sunrise. Any single picture would be inadequate. If I could make a "movie" of many frames taken through an open mind, you would still not distinguish science, but only a moving blur. Really to see things, we need about a twenty-fifth of a second per frame. Science moves much faster than that. So any picture of accomplishments is neutral gray, much as newspapers appear feeding rapidly from a printing-press.

I shall select unrelated and peculiar pictures which do not seem to blend. By my poor lighting, I lose detail and by speed I spoil clearness. Perhaps also most important things are left out—spiritual things—but science is still a little confused there.

See first the animal itself, forced to experiment in order to keep alive. He tries, tests, and names everything, but apparently creates nothing at all. He may *never* create, but he may continually put discoveries together in new ways. The log which saved him from drowning has become the steamship of today. His magic for keeping the wolf from the door—those pictures he scratched on the cave wall—continues to work under improved conditions, and so we see the graphic arts, writing, printing, and painting, still disclosing through new experiments, additional ways of keeping that animal aloof.

My next picture is really a growing cerebral cortex. It seems to be the high-up part of the nervous system which, in all animals, has grown more complex as the animal tried more and more experiments. It is some kind of record of impressions or sensations. This enlargement of his spinal column, overshadowing several other swellings on his main cord, is always reminding him, even when he is not struggling to keep alive, to try new combinations and to make changes just to learn how his environment may be better used. He seems to be creating his brain. So he now aims to improve things which are already good.

He next reduces labor, increases conveniences and adds to his physical comfort. Mental comfort is still for the future. By his successes it seems as though he aimed directly at the ends attained, and yet, when he finally imitates the birds, he flies in an entirely new manner. When he calls long distances, or peers abroad, or looks intently close up, he uses quite unnatural extensions of his original organs. These result from accidental observations which subsequently give him entirely new tools. Thus everything, including space, seems to grow smaller. And in our second picture he begins to research widely, just because he has seen the value of it.

In this picture we see our industrial research of the modern times. Much of it, too, was done to keep the wolf from the door, but there resulted such things as the controllable wind-pressure of steam, in place of oars and sails, and of harnessed lightning for everyone's use. Things we call engines, for all heavy work, and machine tools of every kind (to displace or to extend hands) are parts of this picture, and the word "gadget" has come to stay.

The pure scientist is my next picture. He sees all truth as ultimately serviceable, and feels the boundlessness of it. He learns that unforeseen facts become valuable assets for improving himself, and that his limitations lie in the growth-rate of his brain cortex. It is not alone gadgets that may be improved, but the designer himself. Therefore, he is searching as never before for every particle of new truth, removing it from the infinite mass of the still unknown for its effects upon him. No encyclopedia can now include even the names of the modern products which form the life-studies of science specialists. No single mind can encompass the new work or even understand the new words at the rate they actually become necessary.

Twenty thousand members of Sigma Xi survey the boundaries between known and unknown over a broader area and by narrower angles than could be indicated by any compass-card, and they find in the tiniest atom an entire new universe.

And so we approach another picture, the Future. We must try to predict from the past. How will man continue to experiment after his needs are supplied? Probably as heretofore, by finding new needs. Clearly he must improve the combination, from tools on the one hand to tool-holder on the other. There's no use fitting fine new adjustments to old-style lathe-beds, for example. So he must go ahead, just ahead of his tools.

Judging from the past, we must picture continued new experiments, yielding unexpected results, these in turn developing new human possibilities and providing needs for what we call "necessities," after the fact. This applies in countless ways, but a few examples will suffice. I omit community interests, sociological and economic research, mysticism, and metaphysics, in order to touch a few changes in human chemical, physical, electrical, muscular, neurologial, psychological, and hereditary individual compositions. The mere words confuse one—they suggest so much. But man will proceed, in the fields which they represent, to try new combinations and to learn how he likes them after the event. He will graft into his cortex new thought, just as he has grafted new bone into his frame. The researches on nerve morphology will extend into mental improvements. He has learned scientific progress and will continually extend it. As long as he effectively reveres demonstrable truth the whole world will go along with him. It is in this immense territory of pure, unprejudiced research in countless divisions of physical science that you men will live and have your being. You will often sense the minuteness of your particular contribution, but dimensions are distinctly our artificial invention. Nature defies them. There are no little or big discoveries to be made, but only true ones. This suggests the wide gulf between pure science and existing metaphysical philosophy.

You may philosophize as you wish. Most people do exactly that! But true scientific work is not done that way. It takes the direct path of demonstrable truth. That is why your scientific publications refer to other people's related researches and seem cluttered with descriptions of possible repetitions. Wishful thinking and speculation serve as catalyzers, but scientific work must not retain such admixtures. My last picture therefore will concern itself with man, from his crudest sensory mechanics to his most wonderfully complex cerebral acquisitions.

INDUSTRIAL RESEARCH

If industrial research were done by more and better people, we should have less unemployment and perhaps none. This is perfectly obvious. There is, and always will be, an increasing circumference of untested assets about us, and an infinitely fertile area for progress just adjacent to the known. At any instant the maturing of some new crop of facts, materializing in gadgets, may put new industries into action. The trouble with us is that there too few and too poor industrial researchers. We have had inadequate mental backgrounds, too little appreciation of science, and too much urgency. In other words, in a

world where we expect continual improvement, there is no quick and easy way to remove the hurdles. So I suspect striving to overcome hurdles may be a necessary part of the game.

But there will always be fresh opportunities for the new generation, so I wish now to make suggestions for the younger members of the Society, and particularly for those who may contribute to the various industries.

Here the question quickly and forcibly presents itself, is it enough in a research laboratory to tackle known difficulties, to improve output, and to analyze competitors' methods and products? The answer is, no! And this leads to asking how far afield should a research laboratory go. The aims of the research group should include protection of the industry against the sure obsolescence due to new discoveries by someone. Discoveries made entirely outside an industry may disconcert and injure it. They may stop the earning power of conservatively invested capital. The harness men and carriage builders of the early days were more or less embarrassed by the oncoming automobile makers, because there was little in the harness or wagon business to anticipate the gasoline engine. Research on the old ground is not enough. One must assume that advances will be continually made in all industry, and try to be party to it. The president of the Telephone Company, recently testifying before a committee of Congress, referred to many unexpected products of research, made by that company, which, almost unavoidably, put the company into new commercial developments like radio, talking motion pictures, etc. The discoveries were made in the course of far-sighted research, and, once their worth was seen, the new processes just had to be carried out and the new products produced. Otherwise some most important matter relating to the main interests of the company might have been overlooked. If, for example, radio in other hands had proved capable of rapid and easy house-to-house talking, with the discarding of wire circuits, great numbers of innocent investors in the Telephone Company, who depend upon its stability, might have been ruined.

Again, if General Electric had not early undertaken expensive research work on radio and power tubes, we should certainly have lost our place in the industry which the high-frequency radio alternator of Alexanderson had given us. The alternators were soon entirely superseded by power tubes at greatly reduced cost, and it was fortunate that we took active part in that development.

Similar duties meet the automobile makers. This is illustrated by the studies they make of paints, stream lines, anti-knock gasolines, of Diesel engines, and of every conceivable source of portable power just beyond the horizon.

Such considerations account, too, for our own development of photoelectric tubes, and, with them, of all sorts of devices depending on this electro-mechanical eye. Its study had become an essential part of the research work on vacua. We had to learn more about all vacuum tubes. So new electron tubes of widely diverse characteristics and capabilities came into existence, and soon all sorts of applications were found for them, from exploring the heavens for nebulæ hundreds of millions of light years away, to producing artificial fever in the human body, and, in between, innumerable gadgets for automatic inspection, control, counting, sorting, and regulating most diverse materials, products, and processes. Thus the electric drive and control systems already marketed by

the company have been made more useful, new systems made possible, and perhaps harmful competition in that field forestalled.

The great chemical concerns interested in gums, varnishes, paints, and synthetic organic products, cannot afford to be idle in the now fertile fields of new synthetic polymers, because many of these are proving superior to natural products. This is true whether it is for molded compounds, surface coatings, electrical insulators, fabrics, or even rubber.

There are large investments in silk products in America. If the industry languishes, the doctor should suggest research, and research is now being carried on with many new artificial fibres where the wood of the tree is used instead of leaves—a perennial supply instead of seasonal. There is no great probability that the complicated machinery of the tiny silkworm was designed to produce from mulberry leaves a product so well fitted for every changing *human* service that better products might not be found. One naturally looks for such discoveries to those experimenters who already know the applications and the limitations of existing products, so that each industry should be inquisitive.

The petroleum industry presents a similar condition. Not long ago its researches were being made by the Indian medicine man, who collected oil in blankets floated on Pennsylvania creeks. All he knew about his research was that it made "good medicine."

Today complex organizations with skilled research men and expensive apparatus detect hidden oil domes and apply novel processes of well-drilling and product-purification. Their highly developed tests of quality now include so much novelty that only extreme specialists understand it. Such organizations are in the best possible position to value any new modification or substitute, and to carry on syntheses which disclose unexpected products for future use.

Modern photographic research also well illustrates my point. We continually see cheaper and better products. Lenses and cameras are being rapidly improved. New optical properties and speedier emulsions are being discovered for landscapes and portraits, movies and colored movies. The texture is being made of finer grain so that more exact microscopic and telescopic reproduction is possible and so the whole photographic industry flourishes.

All this is the conservative end of research. No one is better equipped to approach the novelty than those with so much local experience. The real researcher, the optimist, asks, why not extend the photography out of sight, while the conservative says, why attempt to photograph what you can't see. No one can answer such "whys," but one is productive and the other is not. The closely contiguous fields of invisible light, the ultra-violet, the infra-red, the x-rays and the cosmic rays are in the offing, so you are not surprised to find a large photographic company busily investigating the invisible. There is probably no limit to such expansion, and I am hoping for some sort of x-ray photographs of muscles, of moving viscera, and of nerves and arteries, just because these are the things next to our bones.

I ought to tell you how feebly I illustrate right research. I am tongue-tied. Research is the result of child-like inquisitiveness, and we are likely to check that inquisitiveness, as we do a child's, because we are lazy. It is easier to plan

experimental work close to the old home acre, so we do. In electricity, for example, I can think only in terms of wires, magnetic fields, and wave-lengths, so I lazily encourage inquisitiveness only about adjacent areas. So much has been accomplished with 25 and 60 cycles and a few selected high frequencies in radio, and even with zero frequency itself, that wave-lengths between zero and infinity are definite subjects for research—simply adjoining fields. But this, too, discloses laziness, ignorance, and conservatism, because I have thought only of the obvious. I may have actually forgotten that I never knew what electricity is, and am ignorant of what it might do if freed from the shackles which limited knowledge has forged. We almost need to provide more "accidents," for it is frequently the unexpected effect which drives a researcher into a new and productive field.

So I suggest to young listeners to do pioneer, inquisitive research work in the field opened to them and let others do most of the repeat and repair work. It is almost a question whether you ought not be warned against too great effort expended on long-wanted or prescribed needs. Engineers in any field can easily misdirect a young research man's efforts against impenetrable walls. A long-felt want, like perpetual motion, the philosopher's stone, the fountain of youth, workless weeks, frictionless motion, water substitutes for motor fuel, fireproof organic matter, black metals, and other undiscovered chemical elements are not the most promising targets for research. If a want has been felt long and persistently, it is possible that sufficient heads have already broken over it. It is distinctly more fun, and perhaps more profitable, to utilize things in your own field that you didn't suspect would be needed, even products you didn't suppose could exist.

For youngsters in research I suggest more education and greater specialization. Discoveries and interesting work easily start at the outer edges of the known. Explorers leaving the home town take modern carriers to reach "the open," with the tall trees. They later have to walk some, too. They may view the waterfalls or fertile fields as accidental discoveries, but such things are fixed by inviolable laws, which may be learned. Just as our former open spaces are now partitioned into states, cities, towns, and farms, so science became chemistry, physics, biology, etc., and these in turn multiply and subdivide, putting the most promising values among the younger offshoots.

I wish there were some way to lift the innocent boondoggling leaf-duster from the highway into research in medicine, for example, but he would be in the way and get run over. Even to be interested in medicine now, calls for knowledge of advanced chemistry, physics and what not, and the same applies to most other active fields.

PURE RESEARCH

It is impossible to anticipate science, its consequences and industrial developments. It continually discloses new possibilities, most of which cannot be foreseen at all. The wisest man of Queen Elizabeth's active reign, Francis Bacon, tried to describe the possible novelties which orderly research might disclose. He incorporated his prediction in a short story, "The New Atlantis." He wrote that story to convince people of the value of experiment. It popularized science

He had already tried, by the more pretentious publications, Advancement of Learning and Novem Organum, to educate people. He plainly felt that he had shot over their heads. So the accidentally discovered island, in his popular story, made use of such unheard of advantages as horseless carriages, sailless ships, submarines, human wings, etc. He apparently exhausted himself by his suggestions of desirable but undiscovered things. But no one can exceed his number even now. It is so difficult to think in terms remote from experience. There were over twenty widely different predictions and all but one have been realized. That one seems simple. It is a filter to take potable water from the ocean. That this has eluded research so long does not make it insoluble, but it indicates limits to describing the impossible.

Scientific research is fishing with a tiny scoop-net in oceans of unfathomable depth and infinite area. We make the nets ourselves. Our catches often make a disordered pile, but we may orient them and fit them together as we do jigsaw puzzles. Then someone may give our puzzle one more dimension, like depth, and then we have a new necessity.

It may not have helped aeronautics much for Bacon to make his islanders fly somewhat like birds, but he certainly gave research a first and lasting boost. He may not have written Shakespeare, but suspicion attached to him because he was so wise.

After centuries of research it has been recently said by Hans Zinsser, "There is no just reason to believe that we, transitional creatures in the upward progress of evolution, have reached the highest possibilities."

I doubt if it is recognized that the average research worker is a healthy, justified kind of unselfish communist. He aims at everything and works for everybody. He pays personally for the spread of his propaganda, and broadcasts freely all his home-grown produce. He pays for the publications by supporting the scientific societies which publish for him (if his written work passes their critical examination). Moreover, he is charged extra for reprints of his own scientific papers, and he has established the commendable custom of exchanging freely his reprints with brother scientists. Prodigal teachers and unselfish pure researchers do their individualistic work and pay twice for telling the world. The expense to a good worker may exceed several hundred dollars a year. The better he does it, the more it costs him. I do not know of any other such self-sustained and useful group. In science publications, note the growth merely in chemistry. In 1907, *Chemical Abstracts* published reviews of about 8,000 new papers, about 15,000 in 1920, about 25,000 in 1927, 32,000 in 1930, and 42,000 in 1935. In biological science, for example, the reviews have jumped from 7,000 in 1931 to 10,000 in 1935, and it is clear that this is going to be a most active field.

Sigma Xi is not particularly interested in technical research, nor is that especially exciting. What excites one is the discovery of new facts among the mind-expanding wonders of creation. What do we care about industrial uses of cosmic rays, for example? The wonderful thing is that they exist and have such remarkable properties. They speak a new language which, by effort, we may learn.

A scientist first finds helium in the sun. Another finds it in the earth, and then we fill balloons with it. A scientist finds something irregular in air. Another names it argon, and then we fill incandescent lamps with it.

Pure science encourages its devotees by endowing them with a sort of creator's interest and a forever unsatisfied, seldom dissatisfied affection. It is a wish to observe, to know with certainty, to understand, to construct, to measure and conquer, by personal effort. As I have watched scientists at work I have marveled at the forces with which they concentrate in their individual fields. It is as though they instinctively knew that throughout unending time their contributions would augment by developments which, in the beginning, were inconceivable.

When all is said and done, there is only one thing worth advancing, and that is the mentality of the man.

It is easy to imagine such a new series of improvements as would practically free us of physical effort. A mere local extension of available stock may arrange things so that machines do all the real work. The coal burned at the mine and the electric current used in the most advantageous places might let everyone bask in southern sunshine in winter and fly back north in the spring. But we may be built for something better and much more enjoyable. The processes of greatest interest lie within our cerebral field and as this is central station for our nervous system, and as I am interested in certain aspects of nerve actions, I wish to illustrate pure research by a few selections from that particular area. This serves both to illustrate broad research and is a movie, as it should be.

We ourselves are our nerves except for a lot of common mechanics, and our happiness is bound up with their behavior, whether we talk about simple reflexes or complex brain networks. Research has gradually traced out more and more of these electrical conductors and their interconnections. Their number exceeds all power to count. They serve us our pain. They measure us our pleasure. They predetermine our most refined thinking, and they are made by us for us. They interpret both mind and matter, and they stand for "free will."

Now I shall narrow down my widespread remarks to a few cases. I want to trace lightly the relations between common cold feet and mental gangrene, between chemical hormones and knowledge and judgment. Connecting them thus is anticipating future research, but that is my aim.

Our nervous system is divided into three parts, though it is built as a unit. The autonomic system operates a pair of lines and central stations (ganglia) down the trunk parallel to the spine. They are connected to the main or voluntary system within the vertebral column, so in turn to various parts of the brain, and finally to the top—the captain's bridge, the cortical layer. Another nerve group, also outside the spinal column, courses down from the midbrain to the various viscera, and cooperates and competes with the rest of the autonomic system in trying to keep a fixed or healthy state within the dried skin bags in which our colonial cell immigrants have to cooperate, as Cannon sees it.

This para sympathetic and the ganglianated sympathetic are the antique wiring systems of the early animal. By their continued efforts, now usually quite

outside our consciousness, they preserve our temperature, our combustions, our compositions, etc. Doctor Cannon calls this "homeostasis." It is as though we once knew how to control and mold ourselves, but, after developing *thinking* nerves, we delegated the less important visceral control to automatic mechanisms. Of course, this new cerebral, or voluntary system is the most interesting. If we depended solely upon the autonomic system, wonderful as it is, we should be at a comfortable standstill. We should all be stable and uniform, but we'd never get anywhere or have anything new. Judging from the nervous system as a whole, we are designed for change and growth; in other words, for something better. If we are not getting better we are going wrong; that is, we are becoming mentally or physically ill.

Let us consider first the defects of our machine.

There are a number of maladies which are persistent and nearly incurable. They are among the oldest troubles the race has known. Rheumatism, arthritis, asthma, angina pectoris, osteomalacia, poliomyelitis, Raynaud's and Buerger's diseases, epilepsy and high blood pressure are some of them. A part, if not all, have the peculiar property of being due to spasmic, irregular behavior of the homeostat and of leading to irreversible structural changes. It has been discovered that this peculiarity is often traceable to nerves. "Wires are down," "shorted," or carrying too much load. The insulation may be "all shot," as electricians say. To check this thought, surgeons are cutting selected nerves, and much is being learned thereby. Sometimes, after the removal of part of a nerve (or wire), or even several ganglia (or small switchboards), the rest of the automatic circuit proceeds to do the whole job better. It readjusts things and the patient gets well. I suppose this is because we are provided, as is a battleship, for example, with many repair parts and auxiliary, even hidden, circuits for just such accidents. New wiring connections are automatically made when the demand is insistent.'

Raynaud's disease, which is one of these spasmic nerve disturbances, starts with cold feet and often leads to gangrenous toes and thent to surgical operation. The blood circulation is reduced, not by calcification of arteries (sclerosis), nor by internal organic deposits (thrombo angiitis obliterans), but by irregular nerve control. Leading experts now raise the question, what gets on the nerve? It looks like worry. Further research is indicated, for if mental trouble reduces circulation to a foot, why not also to a brain? The surgeons successfully cut the wiring for Raynaud's disease, therefore they try it for other spasmic maladies. Surgical literature shows that such study is now well under way. But this is really taking place before we know how nerves perform their work and how they share it in their multiple electric circuits.

Surely we ought to do more research on the actions of our nerves.

Throughout this field, a few researchers are busy, as illustrations show. For example, the heart is speeded up by adrenalin, which enters the blood from a gland which is under sympathetic nerve control. But the heart is also retarded by the vagus nerve, which acts independently. The proper heart balance is thus automatically and unconsciously due to nerve action. Do the nerves act like mechanical clamps, electrical devices, or chemical products? Here some

wonderful researches are already being made. It has been shown that less than one part of adrenalin per billion of blood accelerates the heart. Similarly, also, blood passed through a heart retarded by vagus nerve stimulation will retard a second, isolated, heart by mere solution-contact. This shows not only the physical chemical effects of the hormones which circulate within the blood, but also indicates that the local action of nerves, like the vagus, is probably also due to chemical products. Nerves produce chemicals for stimulation. As this stimulation can be brought about electrically, I became interested.

In this connection I must refer to G. H. Parker's work, which I hoped he would describe at this meeting. It illustrates the importance of distant pioneering. It makes one gleefully accept long, new names for useless things. This part of my "nervous" talk I call the embarrassed fish. No one knows much about it. Some human beings get embarrassed and blush. So also do shrimps, frogs, salamanders, fishes, etc. This is nervous, protective coloring. A black bullhead, when transferred to a white dish of water, nervously lightens his skin. Under the microscope the mechanism of the process is seen in the contraction of a lot of black spots in the skin (melanophores). When these are expanded the color is black, but when advised by messages from the optic nerve, they contract and the animal becomes light colored. In the case of the embarrassed shrimp, its eye stalks have been removed and extracted with water. This solution, when injected into an unembarrassed shrimp, produces the anticipated change in its color. Finally, and very significantly, Parker has shown that in certain cases the chemical nerve-product is not soluble in water, but may be extracted by oil, so by injecting the oil solution into other fish the color becomes changed near the treated spots.

This is one of the many cases where the immiscibility of oil and water is emphasized and utilized in Nature. It is not new that fats are oils and that contact between the two is common in animals and plants. Probably many processes of growth depend on the presence of the pair in contact. Surely Nature has adapted itself to this mixture and adopted its dependable properties. So while we may never completely understand their functions, we like to consider them just the same. The oils may carry in solution compounds insoluble in water. The aqueous plasma carries salts insoluble in oil. When the two solutions come into contact, new compounds of the two components may be found. Such reactions may well be closely connected with nerve action, as they probably are with tissue growth, calcification, etc. This makes some of Doctor Langmuir's researches on molecular films doubly interesting to me. For example, an inert oil floats as a lens on water. If a little stearic acid be dissolved in the oil, and if the water contains a little calcium, there is formed at once a film of calcium stearate which is quickly forced out from the oil-water surfaces and grows to a compact molecular film on the water. This film neither the water nor the oil seems to care any further about. Perhaps this is a part of the picture of growth. At any rate, it lies at the extremity of current biological science.

Cannon looks "forward to new triumphs of physiologic investigation, and that fair prospect lies in the direction of the nervous system." This is scientific

modesty. Knowing much less of the subject, I am not so careful. All our troubles and pleasures are in the final analysis neural. From the pain of a cold toe to the happiness of some constructive mental process, our nerves are the necessary generator and network. From dreams of avarice to indigestive nightmares, all the information comes to nerves through nerves. Moreover, all the storage of past records lies probably intact in nerve structures and might be available if we better knew the system.

The nerve groups which control our insides willy nilly, without consulting our cerebral system, seem to differ in themselves as though competition were necessary even for the smallest organ. Chemists understand balanced reactions and know that the equilibrium condition is not idleness but represents stability, just because two necessary reactions are doing all they can in opposite directions. This proves that good living itself is process rather than product. Researchers discover that one group of nerves cooperate with ductless glands and the heart to keep the blood supplied with various catalyzers, which react on all the organs both to buck them up and tone them down. And as though this were insufficient, the parasympathetic part of our automatic outfit gets in its work by quickly supplying particular organs, modifying and controlling chemical products which refine, correct, or overrule, where needed, the general actions of the less exacting and more diffuse sympathetic system. Probably all processes that proved desirable, among those of the simpler nerve system, were adopted into the cerebral system as it developed from the lower states of man. So some day we may begin to see how beer and pretzels change into music, arts and science—or Brahms, Cellinis, and Pasteurs.

Just imagine how far such studies might extend! I have thus speculated at this point, because I am speaking of the Future of Physical Science.

President Durand introduced Prof. Frank R. Lillie, of the University of Chicago, to give the second formal address of the morning.

PROFESSOR LILLIE

THE ACCOMPLISHMENTS AND THE FUTURE OF THE BIOLOGICAL SCIENCES

(THE MEANING OF FUNCTION IN BIOLOGY)

Biology is the study of the living. The diversification of the organisms that constitute the "living" is so extreme, that, after a lifetime of concentrated experience, wonder still grows that beings, whose range of tolerance of external conditions is so limited in a physical sense, have nevertheless penetrated so deeply and so widely into the five or six vertical miles above and below the surface of the earth, within which alone the possibilities of active continued existence obtains. Organisms have made the best of their limitations, and have developed adaptations for survival in most of these terrestrial environments, including the bodies of other organisms.

All of this bewildering variety and multitude of organisms constitutes the material with which biology has to deal. The taxonomists have not yet completed the task of enumeration of species, which the Lord God assigned to Adam before as yet he had any helpmeet.

The biological sciences represent a selection of ordered and tested experiences concerning the living, made for various reasons; into which the historical element always enters—the continuity and evolution of culture and its shifting background. The most fruitful urge has undoubtedly been invincible curiosity; this was the sole motive, as I conceive it, of such leaders as Aristotle and Darwin. But all though history the urge to control the hard conditions of existence through agriculture, medicine and other practical pursuits has cooperated. Indeed it may reasonably be urged that men were farmers before they were philosophers.

The great accomplishment of biology has been the gradual development, confirmation and establishment of the conception of the unity of the life sciences, for which more or less separate historical origins can be traced. We owe the first clear expression of this conception to Lamarck (Histoire Naturelle des Animaux sans vertèbres—1816). He defines the essential character of living beings as follows: "All living beings have a similar method of origin, similar periods of existence, and of needs to be satisfied in order to survive; and they exist only by virtue of an internal phenomenon called life, and an organization which permits this phenomenon to operate." He continues: "It is to these special and truly wonderful bodies of which I have just spoken that the name *living beings* has been applied; and the life that they possess, as well as the faculties which characterize them, distinguish them clearly from all other bodies in nature. They offer in themselves, and in the various phenomena that they present, the materials of a special science not yet founded, which even has no name, for which I have proposed some principles in my *Philosophie Zoologique*, and to which I shall give the name of *Biology*."

"Everything common to plants and to animals as well as the faculties peculiar to each of these beings, without exception, should constitute the unique and vast field of Biology."

Later studies, after Lamarck, confirming his belief in evolution, extended the evidences and the factors, established the idea of biology as an independent science and wrought into it conceptions of genetic continuity, of similarity of chemical constitution and metabolic processes, of cellular structure, of common principles of inheritance and modes of reproduction, of environmental relations and behavior, not known to Lamarck.

The question: what is biology?—is, however, a much more difficult one than the question: what is physics? For the biologist has to take careful account of the thinking subject, and to include him among other relevant data; whereas the physicist may treat him merely as the common denominator of all measurements, to which, therefore, all is relative; but nevertheless subject to elimination from both sides of the equation. The inclusion of the thinking subject in biology is necessary whatever our metaphysical conception of him. The creations of man in philosophy, art, religion, science, industry, society and govern-

ment are data of biology in the same sense as songs and nests of birds, for example. A system of biology that is forever incapable of accounting for these phenomena is at least an incomplete system.

We accept the distinction between the living and the non-living for our present purpose, without laboring the problem of the ultimate distinction, if it exists, that has perplexed so many minds. Perhaps the most general distinction between the physical and the biological sciences is contained in the biological conception of *function,* that is, the rôle that the analytic part plays in the integrity and preservation of the operative whole. Function in a broader sense is that which yields survival value.

How does a species or an individual persist? Because its entire organization is in harmony with its environment, or can adapt itself to the changes of environment encountered. This in turn is dependent on the harmonious operation and adaptability of its parts. The test of the individual is its capacity for survival.

How then can we proceed to study function? The first step in this complex undertaking is the process of anatomizing; thus we discover organs, tissues, cells and intercellular constituents, cytoplasm, nucleus, chromosomes, genes, colloids, proteins, etc., carbon, oxygen, hydrogen, nitrogen and many other elements, electrons and all the remainder of the intra-atomic complex. We must add also, of course, that we analyze also the environment down to its component parts significant for the life processes. Naturally the process stops at the point of loss of significance for the contemplated investigation.

This anatomic analysis is always made with reference to a specific problem and on the basis of a definite working hypothesis, which determines where the process should stop. At the end we may have an enzyme, a vitamin, a hormone, a neuro-humor, a gene, an immune body, or what not.

But the process of analysis does not complete the biological problem. The final step is one of synthesis, the restoration of the actively functioning organism, with the resultant gain that we understand a certain function better, and to that exent can control corresponding processes in the organism. This is, of course, an idealized scheme and takes no account of the numerous "trials and errors" of the investigator.

But what is it that we put together in this process of synthesis? If our analysis is complete, we have isolated only a very small part of the organism, or a single factor of the environment, and our synthesis consists in adding this to the organism. *The synthesis always involves the living organism.* The test of correct analysis and synthesis is the restoration of a normally functioning individual. The relation discovered is the function. The organism is thus always the ultimate indicator in experimental biology.

The same is of course true when we are considering two or more intraorganic factors, with or without reference to extraorganic factors, or extraorganic factors alone with reference to the intact organism.

Now what we discover by such anatomizing is always mechanism in the ordinary sense. Hence has arisen the idea that the organism is a kind of mosaic of such analyzed-out mechanisms. I quote a recent expression of this view: "The evidence points to the conclusion that the human being is nothing more

than a physical-chemical-mechanical conglomerate." (C. C. Furnas: "The Next Hundred Years. The Unfinished Business of Science." 1936. Reynal and Hitchcock, Inc., p. 85.) This statement overlooks the fact that only realizable synthese involve the living organism as one factor; it is entirely baseless in fact, and, unfortunately, injurious in effect.

I know of nothing in the realm of science more fascinating, or more rewarding, than the search for, and the discovery of, the mechanisms hidden in the functioning organism. It is certain, however, that the mechanisms that we discover, in each case enter into the composition of a specific organic unity, that displays functions of its own kind, and on its own level of organization. Thus, when the female hormone was first partially isolated, we tried its effects on fowl, and found that, in addition to stimulating the development of the oviducts of females, it brought about a transformation of the beautiful male feathers into the more somber female types. However, the hormone was derived from mammalian sources, and had effects on female sex characters of various species of mammals—in each corresponding to its type of organization. The action of the female hormone is specifically different in each variety of animal in which it is effective. The same principle applies to other biological mechanisms.

Specificity of action applies not only to different species, but also to a certain extent to different stages of the life history. Time is of the very essence of life, and is required for biological organization, whether arising in the course of countless ages of evolution, or in the course of the development of the individual. It is chiefly organization that undergoes evolution and development in biological time, and not so much the simpler analytic elements of such organization.

It is clear, therefore, that biologists must study functions at their own levels of organization, as well as analytically. Each discipline will define its own levels; but more general levels such as psychology and behavior, ecology, embryology, and morphology may be specially noted. Each has its own conceptions, regularities and laws.

At such levels we discover most amazing aspects of regulatory processes within the organism, involving maintenance of states of balance, both physiologically and with references to processes of repair; adaptations, conscious and unconscious, to changing environment, and processes of development in which structural preparations are made for future functions.

In his book on "Bodily Changes in Pain, Hunger, Fear and Rage" (1929), after an analysis of the mechanisms of these phenomena involved in the visceral nervous system, in the adrenal glands causing increase of blood sugar and other changes in the blood, and in the behavior of effector organs, Walter B. Cannon remarks: "The most significant feature of these bodily reactions in pain and in the presence of emotion-producing objects is that they are of the nature of reflexes. The pattern of the reaction, in these, as in other reflexes, is deeply inwrought in the workings of the nervous system, and when the appropriate occasion arises, typical organic responses are evoked through inherent automatisms."

"It has long been recognized that the most characteristic features of reflexes is their 'purposive' nature, or their utility either in preserving the welfare of the organism or in safeguarding it against injury."

In embryology every major event is forward-looking, at least in the most obvious of its aspects. In my first publication in 1895 I called attention to the fact that this is characteristic even of the earliest stages, the cleavage of the egg, where the rate, direction, and equality or inequality of the divisions of the cell may be related to the formation of organs of particular functional significance and time of activity, early or late; a phenomenon that I called adaptation in cleavage. C. E. Coghill in his remarkable study of the embryonic development of behavior patterns in Amblystoma shows how neurone patterns precede behavior patterns. The problem of embryonic behavior is in a sense solved in advance. "There is conclusive evidence of a dominant organic unity from the beginning."

We might, of course, note innumerable similar examples.

Such phenomena lead to the organismal conception, that unity both in space and time is primary, not secondary, that the organism produces its parts, and not in *vice versa*.

If there is an apparent contradiction of terms between organismal and mechanistic aspects of biology, it must nevertheless be maintained that it runs through every department of biology. The togetherness is natural; separation can be made only by mental abstraction. For my own part I feel that we have here the greatest problem of theoretical biology, one in which the sequence of cause and effect appears to be overthrown. An enlargement of our basic scientific concepts is demanded. Somehow in the concept of the wholeness of the individual in time, the scientific approach to the study of the problem lies. The process of analysis reveals *mechanisms of control* of this unity.

Huxley in 1851 ("Upon Animal Individuality," Notices of the Proceedings at the Meetings of the Members of the Royal Institution, Vol. 1, 1851-1854, London) defined the biological individual as "the sum of the phenomena presented by a single life; in other words, it is all those animal forms which proceed from a single egg taken together."

May I restate this by saying that the biological organism *is* its life history complete from gametes on; this is the real unit of biology. This unity of the life history is implicit in Weismann's conception of the germplasm; and becomes more explicit in the modern genetic theory of chromosomes and genes carried unaltered throughout the life history in all cells. Prospective significance in embryonic development is based on the conception of unity of the life history; functional relations in physiology imply the same principle; adaptive behavior and learning in psychology have similarly reference to the past and future, and similar implications of the unity of the life history of the individual. The phenomena exhibited by the biological individual are thus happenings within a single event, which, as such, appears to modify their sequential character in ways not contemplated by mechanistic theory.

Whitehead states the general problem thus ("Science and the Modern World," 1925, p. 151): "It remains an immediate deduction that an individual entity, whose own life-history is a part within the life-history of some larger, deeper, more complete pattern, is liable to have aspects of that larger pattern dominating its own being, and to experience modifications of that larger pattern reflected

in itself as modifications of its own being. This is the theory of organic mechanism."

This is radically different from the vitalistic controversy! The conception "vitalism" belongs properly in the metaphysical realm, as the postulate of non-perceptual factors operating in the perceptual realm of science; and should not be attached to views that emphasize the significance of organismal unity in biological research. It is quite unnecessary at the present time to renew the spirit of the battle with the bishops of Huxley's time! Certainly, that functional aspect of biology, that deals with and measures phenomena on their own levels, is as scientific in method and aim as the prevailing mechanistic biology, and no more metaphysical.

CONCLUSION

The future of biology is a fascinating theme for the romanticist—witness H. G. Wells and Aldous Huxley. But it is a very dangerous theme for the scientist. Each specialist can, of course, project his interest forward into the future, and does so as a matter of fact in each research that he undertakes. His working hypothesis involves more general or remote, and more special or immediate elements. Thus when the influence of the gonads upon bodily characteristics began to be more intensively studied some twenty years ago, it was already realized that it depended upon some internal secretion, and the immediate problem was to produce the effects by an extract, rather than by transplantation of the gonads themselves. The first task was the preparation of an active extract; which proceeded by trial and error; but the hypothesis was already stated, that the essential active factor would turn out to be a substance or substances of specific chemical nature, which might conceivably be synthesized. Essentially the entire program has been worked out as visualized with the incidental results of creating many entirely new problems.

A symposium of specialists in any field would similarly give us a rather trustworthy forecast of the immediate future. But the more remote the future the less trustworthy does it become, up to entire unpredictability.

The future of discovery is essentially unpredictable. In what spirit, then, should we face it? Considering the fact that the minute span of a century, historically considered, building on the long preparation from the time of classical antiquity, has wrought such wonderful results for human culture and human needs, I would say we must face the future with a spirit of the greatest confidence and enthusiasm. This is indeed the spirit of current biological research. The century just passed has been indeed a wonderful century in the history of biology.

In the heat of excitement of modern scientific investigation, and in our natural admiration of the stimulating results and the satisfactions that they supply, I think that we forget all too easily the brevity of the period in which the whole superstructure of modern science has been erected. It is hardly three hundred years since Galileo and Newton laid its foundations. What a brief period even in recorded human thought! And how infinitesimal in the life of man yet to be on this planet! How incredible that in this brief period we should have discovered all means of approach to natural knowledge!

We stand only at the threshold of biological research. I am sure that each specialist would confirm this statement for his own field and assert that the future is full of opportunity.

When a geographical territory is waiting to be explored and conquered, we can divide it into subordinate areas, and can assert truthfully that with the survey of each area a certain proportion of the task is accomplished. The basic sciences are sometimes regarded in the same way; indeed all too frequently I think. But it is at least arguable, certainly in biology, that the progress of research creates more problems than it solves; that the faculty of imagination, which is at the bottom of all creative research, is not satisfied with its diet of results, but is on the contrary stimulated to new growth. Thus, while we can clearly perceive that we are mere beginners, there is no way of anticipating the future of research nor the evolution of human intelligence.

All of this might lead to the homely aphorism that there are as good fish in the sea as have ever been caught. This is almost certainly an analogical understatement, so far as the biological sciences are concerned. Experience has taught us that research in the biological sciences has yielded the richest kind of results for human culture and well-being. With free research, adequately supported, knowledge grows, and new ideas emerge. Without research there is no increase in knowledge and no progress in ideas. The lesson for society is to support free and independent research, and to have abiding faith in the future results.

Biological science is finding its place in medicine to an ever-increasing extent, in pharmacy, in agriculture, in forestry, in the packing industries, in fisheries, and wild life conservation, and in a great variety of government scientific agencies. As population pressure increases, it is finding its way into social and political life. That all of these functional activities will reciprocally exert a great effect upon the development of the biological sciences there can be no doubt.

Granted the preservation of civilization and the continuity of culture, the biological sciences should make great contributions to the evolution of society. Such direction of biological research should be a strong stimulus to the biological sciences, not merely in a quantitative sense, but also in the activation of original ideas, provided that the functioning organs of society that thus profit will actively realize that their best long-time interest is involved in the new, rather than in the mere exploitation of the known.

But professions and industries and government agencies can hardly be expected to pursue a purely rationalistic course within the confines of their own organizations. The untrammeled universities are the great homes of original scientific discovery. Hence the industries and the government would be well advised to support their independence and freedom liberally. There is a tendency on the part of these agencies, and also on the part of the great foundations, to offer support for specified investigations, only of presumed promise. Too much of this may cripple freedom of inquiry.

(Please turn to page 115)

DOCTOR DURAND

THE PRESENTATION OF THE MEMORIAL TABLET

The Society of Sigma Xi has desired to leave here on the campus of Cornell University, the place of its birth and the cradle of its infancy, some enduring memento of this occasion, marking the turn of the half century in its life. We have desired that this memento might take some form which would not only indicate the existence of our Society, but as well, call to mind some remembrance of our ideals and our purposes.

By ourselves, we should, perhaps, have found this not an easy task. Happily this problem has been solved for us through the generous offer of Cornell University to give to our memento such a setting as should meet most admirably our largest hopes in these regards.

To this end, Cornell University is furnishing this beautiful granite seat as a setting for this bronze tablet, which I now disclose to your view—with an inscription reading

THE SOCIETY OF THE SIGMA XI
DEVOTED TO RESEARCH IN SCIENCE
HAS PLACED THIS TABLET HERE
ON ITS FIFTIETH ANNIVERSARY
TO COMMEMORATE THE FOUNDING
AT CORNELL UNIVERSITY
1886 1936

And so, Provost Mann, in the name of the Sigma Xi, I present to Cornell University this tablet with the expression of the hope that those who pass by may perchance be attracted to pause and read, and that those who read may on occasion have some moment of leisure to rest here and look out on the beauties of this campus; and in such moments perchance catch something of the spirit and purpose which has brought the Society of the Sigma Xi from the days of 1886 down to this day of 1936; and this with some quickening of the soul which may perchance stir them to a livelier sense of obligation to give of themselves more largely in the service of the advance of civilization, in whatever walk of life or type of service their own particular efforts may chance to fall.

And so may we feel that we have, through this tablet, added perhaps, some small increment to the spiritual atmosphere which for now so many decades has been the heritage of the sons and daughters of Cornell.

Dr. A. R. Mann, provost of Cornell University and president of the Cornell Chapter of Sigma Xi, accepted the memorial on behalf of the University.

THE BRONZE TABLET OF THE SEMI-CENTENNIAL MEMORIAL

DOCTOR MANN

ACCEPTANCE OF THE SIGMA XI MEMORIAL

President Durand, Ladies and Gentlemen:

On behalf of Cornell University I am most happy to accept this memorial, placed here by the National Society of the Sigma Xi in the shadow of the building where a half century ago a group of young men had a vision. The pleasure of the moment is greatly heightened by the fact that the presentation has been by you, Mr. President, for many years a distinguished member of the faculty of Cornell University; and that it has been made in the sight of three of the founders of the Society, hale men, all, after the passage of these fifty years. The presence here of Frank Van Vleck, William A. Day and William A. Mosscrop, who, with seven others, gave this Society to the world of science and learning, enriches this occasion immeasurably; it gives it almost an immortal touch. The presence of so many representatives of sister chapters and of the American Association for the Advancement of Science, which has honored Sigma Xi and Cornell by its participation, makes the event especially notable.

You have felicitated Cornell, and we are grateful. Your coming here, however, possesses a far deeper meaning than tribute to a particular university. The significance of this ceremony lies in its high recognition of the fellowship of men and women of science made effectual through association in societies devoted to the discovery of new truths and the promotion of scholarship. When Sigma Xi was founded such fellowship was limited. Today it is the privilege of many—indeed, of most if not all of the alert spirits. With the development of associations of scientists the progress of scientific discovery gained momentum and the deeper compensations of men of science as "companions in zealous research" multiplied. Such fellowship and associations have become essential attributes of progress in learning. Today we attest that fact by dedicating a memorial to the founding of a society of scientists.

It was Cornell's good fortune that the Society of the Sigma Xi came into being on its campus. From its foundation Cornell had espoused the cause of science and so provided a hospitable soil for the growth of the idea which became the society memorialized on this tablet. While Cornell acknowledges a possibly pardonable pride as the birthplace of the Society, may I assure you that the University will cherish as an enduring memory the great honor accorded it today by the nation-wide community of scientists.

As spokesman for the administration and faculty of the University and of the Cornell Chapter of the Society of the Sigma Xi, I thank you, President Durand, and your associates in the National Society for this enduring memorial. As one of Cornell's most treasured possessions it will, we trust, beckon countless generations of youth to a fellowship rich in its traditions and prophetic in its significance.

CHAPTER DELEGATES TO THE SEMI-CENTENNIAL

(As reported to the National Secretary. Chapters arranged alphabetically for ready reference)

ARIZONA
BROWN
BUFFALO—Albert R. Shadle
CALIFORNIA—C. B. Lipman, A. O. Leuschner, R. T. Crawford
CALIFORNIA AT LOS ANGELES
CALIFORNIA INSTITUTE OF TECHNOLOGY—Fred B. Converse
CARLETON—(R. G. Waggener)
CASE
CHICAGO—G. M. Dack
CINCINNATI—S. B. Arenson (C. B. Hoffman)
COLLEGE OF MEDICINE, UNIVERSITY OF ILLINOIS
COLORADO
COLUMBIA
CORNELL
DISTRICT OF COLUMBIA—N. H. Heck, Albert L. Barrows, A. F. Woods
DUKE—George T. Hargitt
HARVARD
IDAHO—Ruth Remsberg
ILLINOIS—C. T. Knipp, Elmer Roberts, H. J. Van Cleave
INDIANA
IOWA—Walter F. Loehwing
IOWA STATE—P. H. Carr
JOHNS HOPKINS
KANSAS—Peter W. Claassen
KANSAS STATE—Roger C. Smith, J. S. Hughes
KENTUCKY—W. D. Funkhouser, F. W. Warburton
LEHIGH—P. L. Bayley, Bradford Willard
MARYLAND—M. M. Haring, Charles W. England
MASSACHUSETTS INSTITUTE OF TECHNOLOGY—Karl T. Compton
MAYO—T. B. Magath, J. L. Bollman
MCGILL—David Keys
MICHIGAN
MICHIGAN STATE
MINNESOTA
MISSOURI—Eli S. Haynes, O. M. Stewart
NEBRASKA
NEW YORK—Gustave J. Noback
NORTH CAROLINA—E. K. Plyler, W. F. Prouty, E. L. Mackie
NORTH DAKOTA
NORTHWESTERN—(F. Kraft)
OHIO STATE—Fred A. Hitchcock
OKLAHOMA—V. E. Monnett, Wm. Schriever, H. A. Shoemaker
OREGON—P. I. Wold, A. F. Moursund, Kenneth Swan
PENNSYLVANIA—C. E. McClung
PENNSYLVANIA STATE—A. K. Anderson, F. G. Merkle, N. W. Taylor
PITTSBURGH—C. G. King
PRINCETON—(E. G. Conklin)
PURDUE
RENSSELAER—Joseph Rosenholtz, Frederick Sebast, Archie W. Bray (Banks)
ROCHESTER—John R. Murlin (W. O. Fenn)
RUTGERS—P. A. van der Meulen, John Small
SMITH—Myra M. Sampson
STANFORD
STATE COLLEGE OF WASHINGTON
SWARTHMORE—John H. Pitman, Scott B. Lilly, Robert K. Enders
SYRACUSE—Henry F. A. Meier (Vernon Young, J. M. Robeson)
TEXAS—John W. Wells
TULANE
UNION—Charles B. Hurd, Frank Studer, David S. Morse

UNIVERSITY OF WASHINGTON
VIRGINIA—J. K. Roberts, Arthur Beven, Wm. McGill
WASHINGTON
WESLEYAN—Vernet Eller Eaton, Frederick Slocum, John Elmer Cavelti
WESTERN RESERVE—(Harold S. Booth)
WISCONSIN
WORCESTER
WYOMING
YALE—George A. Baitsell, Arthur H. Smith, Leon S. Stone

CLUB DELEGATES TO THE SEMI-CENTENNIAL

(As reported to the National Secretary. Clubs arranged alphabetically for ready reference)

ALABAMA
ARKANSAS
BUCKNELL—Norman H. Stewart, W. Norwood Lowry
CALIFORNIA AT DAVIS—W. R. Hinshaw
CLARK
COLORADO STATE
CONNECTICUT STATE—Wm. Fitch Cheney, Jr.
DENVER
FLORIDA
GEORGE WASHINGTON
GEORGIA
KANSAS CITY
LOUISIANA STATE
MAINE—Clarence E. Bennett
MARQUETTE
MASSACHUSETTS STATE—James E. Fuller
MIAMI
MILWAUKEE
MONTANA
MONTANA STATE—Archie S. Merrill
NEW MEXICO
NORTH DAKOTA AGRICULTURAL
OHIO
OKLAHOMA A. AND M.
OREGON STATE
PEKING, CHINA—A. Pen-Tung Sah
POLYTECHNIC INSTITUTE OF BROOKLYN
SOUTHERN CALIFORNIA
ST. LOUIS
TEXAS TECHNOLOGICAL
UTAH
VIRGINIA POLYTECHNIC
WEST VIRGINIA—O. Rex Ford (F. A. Molby, H. M. Fridley, W. A. Koehler)
WICHITA

DELEGATES TO THE SEMI-CENTENNIAL FROM LEARNED SOCIETIES

PHI BETA KAPPA—Wm. L. Bray
NATIONAL RESEARCH COUNCIL—Albert L. Barrows, N. H. Heck, F. W. Willard
AMERICAN PHILOSOPHICAL SOCIETY—Rodney H. True, Clarence E. McClung
NATIONAL ACADEMY OF SCIENCES—Frank R. Lillie, Edwin G. Conklin, W. F. Durand

SEMI-CENTENNIAL COMMITTEES

SEMI-CENTENNIAL CENTRAL COMMITTEE

George Howard Parker, Edward Ellery, George B. Pegram — Representing the Executive Committee
George A. Baitsell, G. W. Stewart — Representing the Society at large
C. E. Davies—Representing the Alumni
W. R. Whitney—Representing Industrial Research
F. K. Richtmyer—Representing Cornell University

CORNELL UNIVERSITY LOCAL COMMITTEES

General committee on arrangements:

(Rooms for meetings, correlating and guiding special committees, all general arrangements, care of special guests)

Dean Richtmyer, *Chairman*
Professor Ellenwood
Professor M. L. Nichols
Professor Upton
Professor Whetzel
Professor William Berry, President of the University of Rochester Chapter

In charge of publicity:

(Before, during, and after meeting)

Mr. Boochever

Committee on transportation:

(Special arrangements for transportation Rochester to Ithaca [rail, automobile, or bus], maps and *all other literature* to be given out at Rochester, parking spaces on and near campus, meeting guests at trains)

Professor MacDaniels, *Chairman*
Dr. LeRoy Barnes
Assistant Professor Fincher
Professor M. L. Nichols
Professor Whiton Powell
Professor Switzer

Committee on registration at Rochester and Ithaca, housing and meals:

(Rooms for Thursday, Friday, and Saturday nights; University facilities tentatively reserved. Meals, except dinner Friday evening)

Professor Murdock, *Chairman*
Assistant Professor Adelmann
Assistant Professor Mackey
Professor Matheson
Dr. L. F. Randolph

Committee on all printing:

(Tickets for dinner, programs, souvenir of meeting)

Professor Claassen, *Chairman*
Professor Maynard
Mr. Patterson

Committee on Semi-Centennial dinner:

Professor Whetzel, *Chairman*
Professor Carver
Professor O. F. Curtis
Professor Kingsbury
Professor R. M. Ogden

Committee on arrangements for presentation of the memorial tablet:

Professor Hollister, *Chairman*
Professor Wiegand
Professor George Young

Committee on trips and guides through buildings and about the campus:

Professor von Engeln, *Chairman*
Assistant Professor Agnew
Assistant Professor J. R. Collins
Professor Knott
Professor Schoder
Professor Stark

Committee on reception and tea:

Mrs. Wiegand, *Chairman*
Mrs. Carver
Mrs. Hagan
Mrs. Heinicke
Mrs. Hollister
Mrs. Kingsbury
Mrs. Maynard
Mrs. Richtmyer
Mrs. Sherman
Mrs. Whetzel

Committee on exhibits of early records:

Dr. L. F. Randolph, *Chairman.*
Assistants appointed by Doctor Randolph

Committee on photographs:

Professor Bradley, *Chairman*
Mr. L. C. Conant
Dr. C. W. Gartlein

Professor Lillie—The Accomplishments and the Future of the Biological Sciences

(Concluded from page 108)

We hear much about the "business of science" nowadays, meaning generally its utility as a social agency, and of the duty of scientists to be socially minded. Consciousness of this duty is growing and should develop still more. But society itself should recognize that the root of science is imagination and devotion to abstract truth; that, so long as the root lives, there is promise of new fruitage; and if it dies the promise is lost. The root must be watered with undying courage and persistence and fertilized with a passion for accuracy. Thus arises the creative scientist. The best investment in science today is in able, free, creative individuals. Society can well afford to support them liberally with full freedom.

At the conclusion of Doctor Lillie's address the entire audience assembled at one end of the large quadrangle at the front of Sibley College, in which building it is thought the Society of the Sigma Xi held its first meeting. Here Cornell University had erected a beautiful granite seat and shaft to which the Society of the Sigma Xi added a bronze memorial tablet commemorating the fiftieth anniversary of the founding of the Society.

MINUTES OF THE MEETING OF THE EXECUTIVE COMMITTEE OF SIGMA XI, ITHACA, NEW YORK, JUNE 18, 1936

The first meeting of the Executive Committee for 1936 was held in Willard Straight Hall, Cornell University, June 18, 1936. Those present were President Durand, Secretary Ellery, Treasurer Pegram, Professor Stadler, Professor Miller, Professor Gortner, Doctor Knight, and, by invitation, Doctor Utley of the Alumni Committee. Business was transacted as follows:

1. Reports of Official Visitors:

a. George Washington University.
b. Carnegie Institute of Technology.

The official visitors to these institutions were Dean Richtmyer of Cornell University and Professor Pegram. The visitors presented formal reports of the results of their visits to the institutions, which are on file in the Secretary's office. Various members of the Committee expressed opinions about the institutions based upon personal acquaintance, and after prolonged discussion it was

Voted—*a.* That the group of petitioners at George Washington University be requested to present a formal printed petition for a charter for a chapter; and

b. That the group of petitioners at Carnegie Institute of Technology be requested to present a formal printed petition for a charter for a chapter.

c. The University of Utah.
d. The State College of Oregon.

The official visitor to these institutions was Professor Leuschner, who presented a formal report of the results of his visits, which is on file in the Secretary's office. Several members of the Committee were personally acquainted with the conditions at both these institutions and gave the Committee as a whole the benefit of their judgment. After prolonged discussion, it was

Voted—*a.* To request the group of petitioners at the University of Utah to present a formal petition for a charter for a chapter, and

b. To request the group of petitioners at the State College of Oregon to present a formal petition for a charter for a chapter.

2. The Distribution of Formal Petitions for Charters Among the Chapters.

The secretary called attention to the facts that prior to 1935 the first opportunity chapters had to become acquainted with petitions for charters for chapters was at the convention at which action was to be taken; and further, that in 1935 the policy was begun of sending such petitions to all the chapters prior to the

convention, in order to give opportunity for their consideration by the chapters; and further, that such petitions, sent out from the secretary's office the first week in December, had not reached some chapters in time for proper consideration before action on them was called for, and hence such chapters had declined to vote on the petitions which were presented to the 1935 convention. Upon consideration of these facts, it was

Voted—That petitions for charters for chapters should reach the secretary not later than November 1 of the year of the convention at which action by the convention was expected to be taken, and that the petitions should be issued to the chapters not later than November 15 of that year.

3. Informal Petitions for Charters for Chapters.

At the meeting of the Committee held in St. Louis December 31, 1935, detailed information regarding the equipment and resources and research work at Rice Institute and Massachusetts State College was presented. The Committee instructed the secretary to transmit this information to the members one month before the June meeting, for their study prior to discussion and action. In accordance with these instructions, the information was sent to the Committee May 15. After full discussion, it was

Voted—That the president be authorized to appoint official visitors to make survey of the conditions at Rice Institute and Massachusetts State College for report at the December meeting.

4. Preliminary Information Regarding Institutions.

a. Wellesley College.

A group of Sigma Xi members and associates at Wellesley College submitted information about the science equipment and resources of the college, together with a statement of research work in progress at the college and a supporting letter from the president. It was

Voted—To ask that the information be manifolded and to instruct the secretary to distribute it to the Committee one month before the December meeting.

b. Radcliffe College.

The secretary reported that information about the research work done by graduate students at Radcliffe had been submitted with a view of presenting later a petition for a charter for a chapter. It was

Voted—That since graduate work at Radcliffe is done under the supervision of the faculty of Harvard University, the secretary be instructed to confer with the Harvard Chapter regarding the possibility of the election of qualified Radcliffe graduate students into membership of the Harvard Chapter; and further, that if inquiry revealed that such election was not possible, the secretary be instructed to ask that the information regarding Radcliffe be manifolded and submitted to the Committee one month prior to the December meeting.

5. Amendments of the Constitution.

At the spring (1935) meeting of the Committee, the Alumni Committee made recommendations regarding the relation of the Sigma Xi Clubs to the national organization, and a special committee (Davies, Pegram, Ellery) was appointed to draft amendments to the constitution to cover the suggestions.

This sub-committee proposed the following amendments:

(1) Article II, Section 2.

Change the wording of the last sentence of the section so that the entire section shall read, "A petition for a charter for the establishment of a new chapter shall be communicated to the President of the Society, who shall refer it to the Executive Committee for consideration. If the Executive Committee presents the petition to the convention with recommendation to favorable action, a charter may be granted by a three-fourths vote of the convention.

(2) *a.* Add a new article to be numbered "Article III," reading as follows:

Article III, Section 1.

A Sigma Xi Alumni Club, composed of local alumni members and alumni associates of the Society, may be organized at any place to engage in activities to further the objects of the Society. The recognition of such a local organization as a Sigma Xi Club shall require favorable action by the Executive Committee of the Society, and the Executive Committee shall have power to withdraw recognition of any Club.

b. Change the numbering of all articles following this proposed Article III.

(3) Change present Article VIII, Sections 1 and 2, as follows:

a. Omit in Section 1 the clause "consisting of delegates from each chapter and from the alumni members of the Society," and add the words "to each club," making the section read, "A regular convention of the Society shall be held annually at such time and place as shall be determined by the Executive Committee, and due notice shall be given to each chapter, to each club, and to alumni members through the official journal of the Society."

b. Omit the article "the" before "delegates" in the second sentence of Section 2 (a), making Section 2 (a) read, "Each chapter in good standing shall be entitled to a representation of not more than three delegates at each convention. The members of the Alumni Committee shall *ex-officio* be delegates representing the alumni members of the Society.

c. Add Section 2 (d), as follows:

"Each alumni club shall be entitled to have not more than three delegates attend any convention. A club delegate shall have the privilege of the floor, to discuss any subject before the convention. Delegates of Alumni Clubs shall be entitled to vote only on questions directly affecting alumni members and associates. On such questions each club shall be entitled to one vote."

(4) Change wording of first sentence of present Article IX, Section 2, so that the section shall read as follows: "Alumni members and associates, including those organized in clubs, shall contribute to the support of the Society in such ways as may be agreed upon by the Alumni Committee and the Executive Committee. All sums so collected shall be separately accounted by the Treasurer of the Society, and shall be known as the Alumni Fund."

6. ANNUAL GRANTS-IN-AID.

It was

Voted—To make available to the Committee of Award of the Sigma Xi Grants-in-Aid a sum not to exceed $2,000 from the general funds of the Society.

In reply to a question raised by the secretary, the Committee expressed the opinion that the grants-in-aid should be paid, as heretofore, to individuals rather than to institutions.

7. THE SCIENCES RECOGNIZED BY SIGMA XI.

In 1928 the Executive Committee voted to limit the fields of science recognized by the Society to the following: mathematics, physics, chemistry, astronomy, sciences of the earth, biology in its various branches including psychology, anthropology, medicine in its various branches, engineering in its various branches.

In 1929, the convention of the Society voted to leave the interpretation of the expression "science pure and applied" in Article I, Section 2, of the constitution to the Executive Committee "with power to take such action as in its judgment would best serve the purposes of the Society."

It was definitely reported to the Committee that not all chapters were limiting their elections in accordance with this action of the convention and the Executive Committee. It was

Voted—To reaffirm the previous action of the Executive Committee, and to instruct the secretary to call the attention of the chapters to the action in October of each year.

8. INSTALLATION OF NEW CHAPTERS.

President Durand reported the installation of the Carleton Chapter April 22, with the President and Professor Gortner as installation officers; and of the Buffalo Chapter April 25, with the President and Secretary Ellery as the installation officers.

9. COMMITTEE ON LECTURES AND PUBLICATIONS.

Professor Stadler reported for the Committee the following topics for lectures and publication:

a. The Physical Basis of Human Behavior.
b. Science and Social Values.
c. The Life Process from the Point of View of the Biologist, the Chemist, and the Physicist.

10. Certificates of Award in Commendation of Research.

It was

Voted—To authorize the President to appoint a committee of award of certificates in commendation of research done by students in institutions where there are no chapters of Sigma Xi.

In this connection two suggestions were made: *a*. That the committee of award be appointed from the faculties at Stanford University and the University of California; *b*. That the convention be asked to grant to the Executive Committee power to elect into the Society's membership or associateship such of these candidates for the certificates of award who, in the judgment of the committee of award, were properly qualified for that recognition.

11. The Sigma Xi Quarterly.

a. Address List.

It has been the policy of the Society for a good many years to send the Quarterly to newly elected members and associates for one year following the receipt of the report of their election to the secretary's office. Notices of these elections reach the secretary at greatly different times in the spring and summer and fall of the year, and in some instances a year or more passes before the secretary is informed of elections, and then only after repeated request. The work of the secretary's office has increased to such an extent during the last decade that this lack of uniformity in the practice of reporting elections and of definiteness in the time of beginning delivery of the Quarterly places a burden upon the office that is almost impossible to carry.

The secretary asked for advice as to the best way of handling the situation. Many helpful suggestions were made. It was

Voted—That the secretary be authorized to distribute among chapter secretaries in the fall of each year postal cards addressed to him, and calling for the name and permanent mailing address of each initiate, to be filled out by the initiate, signed and mailed by the chapter secretary at the time of the initiation.

b. Editorial Staff.

It was pointed out that the Quarterly is now being sent to approximately 12,500 individuals, and that articles are constantly being offered for publication. The demands on the secretary make it impossible for him to give proper scrutiny to all the articles submitted, and the influence of the Quarterly and the extent to which it is read require that either an editor or an editorial staff be appointed to assume the care of this part of the Society's activities. The whole question was fully discussed, and it was

Voted—That the question of editing the Quarterly be taken under advisement by the members of the Committee for discussion and possible action at the next meeting.

12. Sigma Xi Associates and Connection with Chapters While in Residence at the Institutions.

It was reported that associates who after election remain in residence at the institutions where they were elected frequently find it impossible for financial reasons to retain active connection with the chapter. The Committee was of the opinion that the matter should be investigated, and it was

Voted—To authorize the secretary to ascertain from chapter secretaries the extent to which associates withdraw from active connection with the chapters while still in residence at the institution.

13. The Minutes of the Executive Committee.

The secretary exhibited the complete records of transactions of the Executive Committee for the time it was inaugurated, 1916. The minutes are typewritten, and preserved in a loose-leaf notebook. They represent the history of the Society's business for twenty years. Even with the great care with which this record of the Society's business is guarded, there is grave danger of loss of single sheets, or of the record as a whole. The minutes should be preserved in some permanent form. It was

Voted—That the minutes of the meetings of the Executive Committee be duplicated, bound in durable form, and one volume be preserved in the treasurer's office, and one volume in the secretary's office.

14. The Semi-Centennial Endowment Fund.

The secretary reported that an illustrated folder setting forth the purpose of the fund and soliciting subscriptions had been sent to 30,000 members and associates up to the time of the meeting, and that 6,000 more would be sent in two weeks following the meeting. The total sum subscribed at this date is approximately $10,000, and the number of subscribers just under 2,000. The question was raised as to whether a follow-up letter should be issued, and if so when would be the best time to mail it. It was

Voted—That a follow-up letter, repeating the purpose of the fund and soliciting subscription be drawn up by the Alumni Committee and issued in October.

15. The Use of the Income from the Society's Invested Funds.

Announcement was made of the winners of the Semi-Centennial Research Prizes of $1,000 each, in accordance with the action of the Committee in 1932 and 1935 authorizing such awards. (Dr. Richard E. Shope of the Rockefeller Medical Institute and Dr. I. I. Rabi of Columbia University.) The question was raised as to what use should be made of the income from the invested funds in the years to come. It was

Voted—That the president appoint a committee to consider the general question of the Society's policy in the use of the income from invested funds, and that the Committee report at the next meeting of the Executive Committee.

16. Budget for 1936.

The treasurer proposed the following budget for 1936:

Secretary's office, salaries, supplies, postage, etc.	$5,500.00
Treasurer's office	200.00
Officers' traveling expenses	1,200.00
Quarterly	2,200.00
Engrossing charters	100.00
	$9,200.00

Special expenses connected with Semi-Centennial and Half-Century Record and History $1,200.00

Edward Ellery,
Secretary.

CHAPTER OFFICERS

List Furnished by the Secretaries of the Chapters

Chapter	President	Vice-President	Secretary	Treasurer
	A. R. Mann	B. F. Kingsbury	L. F. Randolph	A. J. Heinicke
er	F. M. Sebast	J. B. Cloke	J. D. Kinney	H. E. Stevens
	E. S. C. Smith	V. Rojansky	F. J. Studer	R. W. Abbett
	N. P. Sherwood	W. C. McNown	W. H. Schoewe	H. E. Jordan
	E. O. Waters	A. F. Kovarik	L. S. Stone	H. J. Lutz
ta	W. H. Emmons	W. L. Hart	R. E. Montonna	J. Valasek
a	H. J. Kesner	H. W. Manter	E. N. Andersen	M. G. Gaba
te	S. E. Rasor	E. Van Cleef	F. A. Hitchcock	F. A. Hitchcock
ania	H. S. Lukens	J. L. T. Appleton	E. R. Helwig	J. M. Fogg
	C. Barus	C. H. Smiley	P. H. Mitchell	W. R. Benford
	Alexander Ellett	G. H. Coleman	Beth Wellman	W. A. Anderson
	C. V. Taylor	P. H. Kirkpatrick	V. E. Hall	V. E. Hall
	C. W. Porter	L. C. Uren	S. F. Light	H. E. White
a	M. T. Bogert	H. W. Webb	A. W. Thomas	A. W. Thomas
	F. C. Koch	C. R. Moore	C. G. Croneis	C. G. Huff
	C. V. Weller	H. H. Higbie	R. G. Smith	R. K. McAlpine
	E. Roberts	L. A. Adams	E. G. Young	T. S. Hamilton
	J. R. Martin	G. L. Tuve	R. L. Burington	T. M. Focke
	C. E. May	J. J. Galloway	C. M. Louttit	W. D. Thornbury
	A. E. Stearn	C. W. Turner	M. D. Overholser	Dorothy Nightingale
	H. M. Kingery	G. Alexander R. M. Hill	H. B. Van Valkenburgh	W. K. Nelson
stern	C. D. Hurd	C. A. Dragstedt	R. A. Fisher	A. L. Howland
e	A. L. Elder	Jane S. Robb	J. M. Robeson	W. R. Fredrickson
in	O. L. Kowalke	H. W. Mossman	C. A. Richards	W. E. Roseveare
Wash.	D. H. Loughridge	W. L. Beuschlein	B. L. Grondal	T. S. Jacobson
er	H. A. Maxfield	R. A. Beth	W. E. Lawton	H. B. Feldman
	C. B. Jordan	M. G. Mellon	S. M. Hauge	H. L. Solberg
on Univ.	L. McMaster	J. P. Nafe	C. Tolman	A. S. Gilson
Columbia	Wm. Bowie	F. V. Coville	Miss Vinnie Pease	Wm. Lerch
	R. H. Cuyler	H. R. Henze	H. F. Rosene	P. M. Batchelder
undation	G. M. Higgins	J. L. Bollman	E. V. Allen	E. V. Allen
lina	A. Henderson	E. Bagby	R. W. Bost	R. W. Bost
ta	C. W. Telford	H. E. French	A. R. Oliver	A. R. Oliver
te College (rly *Ames*)	H. J. Gilkey	Rachel Edgar	J. M. Aikman	W. J. Schlick
	A. A. Boyden	I. D. Garard	H. Johnson	E. P. Starke
	J. J. O'Neill	F. M. G. Johnson J. B. Collip	R. D. Gibbs	V. C. Wynne-Edwards
y	S. E. Erickson	O. J. Stewart	M. M. White	A. Brauer
	E. Taylor	J. E. Buchanan	E. C. Jahn	W. E. Shull
ore	S. B. Lilly	H. Brinkmann	H. J. Creighton	H. J. Creighton
	W. D. Smith	E. S. West	C. Hall	A. Moursund
	W. S. Rodman	S. A. Mitchell	J. K. Roberts	J. K. Roberts
Hopkins	W. M. Clark	J. H. Gregory	M. W. Pullen	M. W. Pullen
Inst. of ology	J. P. Buwalda	P. W. Merrill	A. O. Beckman	E. E. Sechler
York	A. E. Hill	G. B. Wallace	D. Ludwig	D. Ludwig
ti	C. N. Moore	J. H. Hoskins	S. B. Arenson	S. B. Arenson
State	S. G. Bergquist	V. G. Grove	R. Hutson	L. N. Field
	R. F. Graesser	H. C. Schwalen	R. E. Heineman	R. E. Heineman
	J. B. Reynolds	C. H. Sutherland	H. A. Neville	A. Butts
	A. L. Schrader	W. B. Kemp	C. E. White	C. E. White
State	R. J. Barnett	J. H. Burt	H. H. Laude	J. L. Hall
Medicine, of Illinois	E. Oldberg	O. Bergeim	W. H. Welker	I. Pilot
ania State	M. R. Fenske	S. I. Bechdel	A. K. Anderson	O. Frink
	F. E. Clements	M. D. Wilson	L. E. Harris	L. E. Harris
of Wash.	H. C. Aase	R. L. McLennan	C. C. Prouty	C. C. Prouty
	S. H. Knight	H. S. Willard	A. B. Mickey	C. L. Farrar
	W. Berry	R. K. Burns	Q. D. Singewald	Q. D. Singewald
h	C. G. King	J. S. Taylor	G. M. McKinley	W. H. Emig
	R. A. Daly	A. B. Dawson	F. M. Carpenter	F. H. Crawford
Reserve	J. P. Visscher	C. J. Wiggers	W. M. Krogman	F. Hovorka
	C. Ten Broeck	N. H. Furman	L. A. Turner	E. Dorf
	W. C. Vosburgh	F. Bernheim	H. J. Oosting	Bert Cunningham
Los Angeles	G. E. F. Sherwood	A. W. Bellamy	H. C. Gilhousen	A. H. Warner
setts Inst. echnology	F. G. Keyes	J. W. M. Bunker	W. C. Voss	K. C. Reynolds
	E. C. Faust	W. B. Gregory	H. N. Gould	H. N. Gould
	M. C. Foster	H. B. Goodrich	C. L. Stearns	C. L. Stearns
	Gladys A. Anslow	N. H. McCoy	Geo. Olds Cooper	Elizabeth S. Hobbs
	F. F. Exner	C. H. Gingrich	M. B. White	N. S. Dungay
	W. J. Atwell	A. R. Shadle	R. R. Humphrey W. D. Langley	C. F. Scofield

SIGMA XI CLUBS

Club	President	Vice-President	Secretary	Treasu
Southern California	H. J. Quayle		H. B. Frost	H. B. Frost
University of Denver	T. R. Garth		E. A. Engle	E. A. Engle
Oregon State Agricul. College	W. E. Milne	B. T. Simms	H. A. Scullen	H. A. Scull
West Virginia University	R. B. Dustman	W. A. Koehler	O. R. Ford	O. R. Ford
University of Maine	W. F. Dove	M. Freeman	M. D. Sweetman	M. D. Sweet
University of Florida	R. C. Williamson	W. R. Carroll	P. A. Foote	P. A. Foote
Colorado Agricul. College	L. W. Durrell	F. P. Goeder	D. Gunder	D. Gunder
Louisiana State University	E. C. Timms	A. D. McKinley	W. Whitcomb	W. Whitcomb
University of Alabama	F. S. Dubois	Anna Church	J. D. Mancil	K. Coons
University of Arkansas	W. M. Roberds		L. B. Ham	L. B. Ham
University of Calif. at Davis	F. N. Briggs		N. E. Edlefsen	N. E. Edlefs
University of Utah	F. F. Hintze	T. J. Parmley	Margaret Schell	Margaret Sch
Clark University	W. W. Atwood		P. M. Roope	P. M. Roope
St. Louis University	F. E. Poindexter	E. A. Daisy	L. F. Yntema	
Connecticut State College	W. F. Cheney, Jr.	E. L. Kelly	C. H. W. Sedgewick	C. H. W. Sed
Miami University	W. H. Shideler		R. V. Van Tassel	R. V. Van T
University of Georgia	A. S. Edwards		J. W. Nuttycombe	B. J. Miller
Bucknell University	W. H. Eyster		B. J. Miller	
Oklahoma A. and M. College	W. V. N. Garretson	F. M. Durbin	J. E. Webster	J. E. Webster
Montana State College	D. B. Swingle	H. T. Ward	P. L. Copeland	P. L. Copelan
North Dakota Agr. College	M. E. High	C. I. Nelson	W. Keck	W. Keck
Texas Tech. College	R. A. Studhalter	H. F. Godeke	W. M. Craig	
University of Montana	F. O. Smith	G. D. Shallenberger	C. W. Waters	
Virginia Polytechnic Inst.	S. A. Wingard		W. L. Threlkeld	
Peking, China	C. W. Luh	C. M. Van Allen	A. P. T. Sah	A. P. T. Sah
Wichita	W. A. Ver Wiebe	C. C. McDonald	E. A. Marten	E. A. Marten
Massachusetts State College	W. H. Davis	F. J. Sievers	C. R. Fellers	C. R. Fellers
Ohio University	R. L. Morton	A. C. Anderson	E. H. Gaylord	E. H. Gaylord
University of New Mexico	S. A. Northrop	E. F. Smellie	R. E. Holzer	R. E. Holzer
Kansas City	J. C. Rice	R. G. Stone	S. E. Ekblaw	S. E. Ekblaw
Polytechnic Institute of Brooklyn	R. E. Kirk	C. C. Whipple	W. H. Gardner	W. H. Gard
Marquette University	H. P. Pettit	D. R. Swindle	J. F. H. Douglas	
Milwaukee	H. P. Pettit	Mary Pinney	M. J. Martin	
George Washington	R. F. Griggs	L. W. Parr	P. W. Bowman	P. W. Bowm

OFFICIAL ANNOUNCEMENTS

SIGMA XI EMBLEMS

All insignia of the Society are available only through the office of the National Secretary. They are made in various styles and sizes, and in white and yellow gold. Orders for these insignia are issued through chapter secretaries, and must be *prepaid*. Information about styles and prices may be obtained from chapter secretaries or the National Secretary.

DIPLOMAS FOR MEMBERS AND ASSOCIATES

These diplomas are available in any quantity at 10 cents each. Orders should be sent to the National Secretary, should specify whether for members or associates, and should be accompanied by check.

INDEX CARDS

Index cards for newly elected members and associates are available *gratis* upon requisition from chapter secretaries to the National Secretary. These cards should be made out in duplicate, one set being retained for chapter files and one set being sent to the National Secretary for filing in the permanent records of the national organization.

NATIONAL CONSTITUTION

Printed copies of the National Constitution, containing all amendments to date, and all recent interpretations as made by the national officers on request of chapters, are available at 9 cents each from the National Secretary.

CHANGES OF ADDRESSES

Chapter secretaries are asked to send to the National Secretary in October of each year changes in their enrollment lists as follows: 1. Names and addresses to be deleted from the previous list; 2. Names and addresses to be added to previous list; 3. Changes of addresses of those on previous list who may have moved to a new address since the list was submitted.

EDWARD ELLERY,
National Secretary, Sigma Xi,
Union College,
Schenectady, N. Y.

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